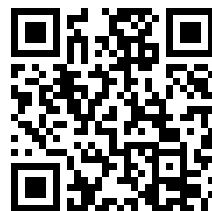


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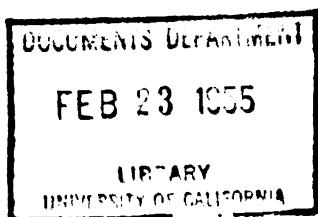
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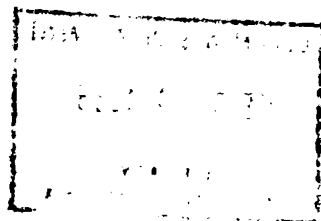
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of the

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## Royal Army



## Medical Corps

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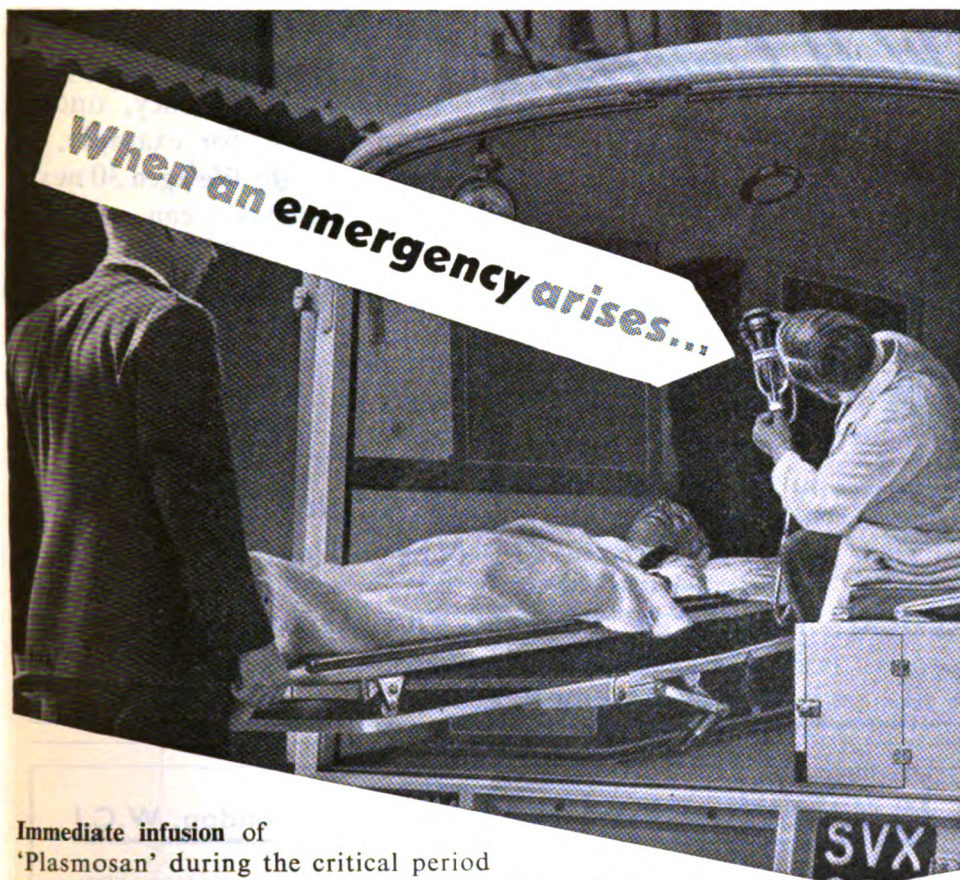
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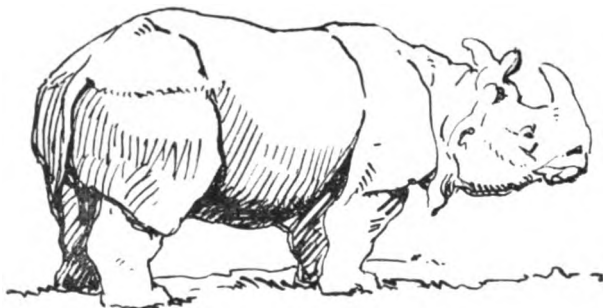
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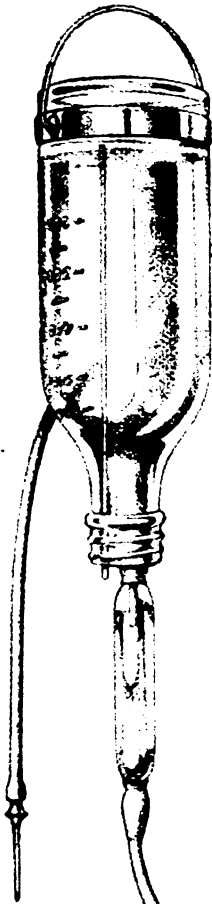
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# Journal of the Royal Army Medical Corps

## *Original Communications*

### THE KNAPSACK AND PACK

AN HISTORICAL AND PHYSIOLOGICAL SURVEY WITH PARTICULAR  
REFERENCE TO THE BRITISH SOLDIER

BY

E. T. RENBOURN, B.Sc., M.D.

*Formerly Major, Royal Army Medical Corps*

*Ministry of Supply: Physiological Research Establishment of the  
Directorate of Physiological and Biological Research*

#### INTRODUCTION : ETYMOLOGY

It may be of interest at the outset to say a few words concerning the origin of some terms linked for so long with the various parts of the soldier's equipment. The word "knapsack" is found for the first time in the English language about the year 1600, and is derived from the Low German *Knappen-Sack*, meaning a food bag. During the first half of the seventeenth century it was commonly referred to by the Saxon derivative *Snap-Sacke* (snap or provender). The soldier's "haversack" is the equivalent of the *Sarcina* (Latin, a bundle), or the osier basket of the Roman soldier which, during the march, was often carried at the end of a forked stick or a spear. The term first appears towards the end of the seventeenth century as the French *abresac*, *habresac*, or *havresac*, and originates in the Low German *Hafer* or *Haber-Sack*, meaning an oat sack as commonly used for horses. The word did not appear in English until the end of the eighteenth century, and is still used in the Westmorland dialect as haver-cake or oat cake. We first hear of "canteen" in 1744; the word appears to be

derived from the Italian *Cantina*, meaning a wine cellar, or a receptacle for liquids. References to the word "webbing" do not appear in military dictionaries of the last century, but the following is noted in 1745: "Welch Webbing—a thick sort of woven flannel of which soldiers' clothing is chiefly made."

#### SEVENTEENTH CENTURY

The first British "Commission on Uniformity of Arms and Armor" met in 1631 and, after deliberation, introduced a sealed pattern of arms and accoutrements. As a result, the powder charges of the musketeer were carried in a bandolier and the bullets kept in a bag or loose in the pockets. A knapsack of canvas or fur was carried over one shoulder. Although by this time armour had almost completely disappeared, it was still being worn by one or two regiments; but we are told by General Monk, later the first Duke of Albemarle, that "the defensive Armor of a musqueteer is a good courage." The cuirass (French, *cuirasse*—a leather jacket) worn by the cavalry of Sir Arthur Heselrig's Parliamentary Regiment was of bright iron shell, and received from the Royalist soldiers the nickname of "Heselrig's lobster."

The pay of an infantry soldier in Cromwell's army was a mere pittance of about eight or ten pence a day, of which sixpence was put aside for his "Subsistence"; and for this he was expected to march a full twelve miles or more. Although in the times of the New Model Army discipline must have been rigorous, there is evidence that (as found throughout the ages) "Pack Boys" and pack animals were employed for carrying the soldier's load. Sir James Turner, when speaking of this period in his *Pallas Armata*, written in 1670, tells us as follows: "And although I joyn freely with him in his opinion, that the Souldiers should not carry such burthens as the Romans did of old, yet I would have neither Horse nor Boy allowed them; it is too much, that the Custom of later times, hath eas'd most of them of the burthen of defensive Arms, and therefore every one of them may, and should, carry his own knapsack, and four or five days provisiōe of meat, with a Hatchet at his girdle, which I see too much neglected, on this side of the Sea. . . . Though you allow every Souldier two pounds of Bread and Cheese every day, and God knows, he gets not so much, many times in four days. . . . Suppose he hath a couple of shirts and a couple of Stockins, and a pair of Shoos in his knapsack (and how many Souldiers have all of these), and a Hatchet, I say all of these will not weigh as much as a Head-piece and a Corslet, and he therefore may be well enough be obliged to carry them" (1).

#### EIGHTEENTH CENTURY

In 1752 Sir John Pringle, physician to the Duke of Cumberland, published his classic on Military Hygiene, and this became the standard work in England and on the Continent for almost a hundred years. We are told that "the life of the foot soldier, is divided between two extremes of labour and inactivity. . . . Sometimes when he is ready to sink under fatigue, having his arms, accoutrements and knapsack to carry, he is obliged to make long marches, especially



FIG. 1. INFANTRYMAN

Showing crossed belts and regimental breastplate, under which the chest strap can be seen, haversack and water canteen slung from the left shoulder (circa 1812).

FIG. 2. WINTER UNIFORM

Showing knapsack, canteen (mess kit) and ammunition pouch, haversack and water canteen slung from right shoulder (circa 1814).



in hot or rainy weather" (2). Apart from this statement, Pringle expressed no interest in either the weight of the load, or its mode of carriage.

During the American War of 1775-1783 the British soldier met the enemy in a fashion aptly described by a contemporary Colonel Lloyd : "We borrowed from Germany cross belts which compressed the chest but had the disadvantage of throwing the sword to the rear, and to knock against the calves and cartridges, and to quarrel with the havresack ; long gaiters which squeezed the legs and stopped the circulation in that useful member of the foot soldier, stocks which forced his head up even with the sun in his eyes, curl papers and tight shoes." When the unpopular "queue" was done away with in 1808, the stocks became even higher. After the war, the Board of General Officers produced an improved pattern of infantry accoutrements. The single or crossed shoulder belts became narrower and lighter but remained of buff leather. The magnificent large ornamental buckles disappeared and were replaced by a small but handsome regimental breastplate, positioned where the belts crossed in front (Figs. 1 and 2).

#### PERSONALIA OF THE CAMP

From time immemorial, the movement of armies has been impeded not only by the weapons and equipment of the soldier, but also by women and other Personalia of the Camp. Sir James Turner, in his inimitable style, wrote again as follows : ". . . The Second Classe of Women is of those who ride on horseback, and these must ride in no other place than where the Baggage of the Regiment, to whom they belong marcheth ; but they are very oft extravagant, gadding here and there, and therefore in some places they are put into companies, and have one or more to command and over-see them, and these are called in Germany *Hureweibles*, Rulers or Marshalls. I have seen them ride, keep Troop, rank and file, very well, with that Captain of theirs . . . and a Banner with them, which one of the Women carried. . . . They provide and dress their husband's meat . . . they bring in Fewel for fire, and wash their Linnens. . . . That famous Duke of Alva . . . they say . . . he was given permission for Courtizans to follow his Army, but they were to ride in Troops with Banners. They were divided into several Squadrons according to their quality, and that was distinguished no otherwise by the difference of their beauty, faces and features" (1).

An account of an English family, written by the French General Lejeune, during the Peninsular War of 1808-1814 reads as follows : "The Captain rode first on a very fine horse, warding off the sun with a parasol. Then came his wife, very prettily dressed with a small straw hat and riding a mule. Besides madam walked her Irish nurse carrying in a green silk wrapper, the hope of the family. Last in the procession came a donkey laden with much miscellaneous baggage which included a tea kettle and a cage of canaries ; it was guarded by an English servant in livery, mounted on a sturdy cob" (3). Sir George Bell wrote the following during the same period : "The multitude of soldiers' wives stuck to the army like limpets ; averse to all discipline, they impeded our progress particularly in retreats. They became the subject of a General Order

for their own special guidance. Under no control, they were always first mounted and away, blocking up narrow passes and checking our advance with their donkeys" (4).

#### EARLY HISTORY OF THE KNAPSACK

Since the time of Cromwell the equipment of the British soldier has included a knapsack for "Essentials" and a haversack for "Necessaries"; but it is to be noted that the canteen for water—"bluejack" of this period—was not issued to the soldiers during the Civil War itself (5). To near the end of the eighteenth century, the knapsack was a bag of canvas, fur or cowhide, slung over the musket or the right shoulder. The cost was about ninepence in the time of the Civil War (5), rising to a few shillings during the next two centuries. The bag was often painted the colours of the regimental facings, with insignia on the back. After an order of 1798, the knapsack was carried on the soldier's back by two shoulder straps.

In 1805 a certain Mr. Trotter, who supplied the Army with most of its equipment (from his factory in Soho Square), introduced a new type of knapsack. This was a rectangular box of wooden framework, covered with black canvas. After this date, regimental facings and insignia were seen much less frequently. Several modifications of this equipment were issued during the next fifty years. In 1824 regimental records mention a new pattern; that of 1827 was said to be smaller and lighter. The knapsack of 1829 had a stronger wooden framework, with a pocket in the flap. Yet another smaller pattern appeared in 1857 (6, 8). These various modifications were, however, of little practical value to the soldier. Until 1871 the knapsack was itself regarded as a "Camp Necessary" to be provided by "Off Reckonings" or "Stoppages" from the soldier's pay; but after this it became an article of "Equipment" (6, 8).

In the first half of the nineteenth century the British soldier carried his knapsack high on the back, and independently of the crossed belts, by shoulder straps passing high in the armpit to the lower angles of the knapsack. The great coat or blanket was kept in various positions on top of the knapsack. It would seem that the stovepipe shako hat worn at this time must have sometimes been knocked off, and movements of the neck interfered with, during rifle fire or crawling (Figs. 1 and 4). A heavy ammunition pouch was situated over the rump or hip, the weighty wooden water canteen (later called a water bottle) was slung from the left shoulder; and from the right shoulder was slung the haversack, with its rations, extra ammunition and odds and ends. However, it is seen from Figs. 1 and 2 that the position of these pieces of equipment varied somewhat. No attempt was made to co-ordinate the different accoutrements, or to balance the knapsack behind with some load in front. In order to prevent the straps slipping over the shoulders, the former were joined by another strap, buckled tightly across the chest (Fig. 1), and at a level sometimes laid down by an Order, as for instance, that of 1829 (8). This chest strap produced so much distress that it was invariably unbuckled on the march; and we are told that at "the double" the soldier had to "put his hand on his cap, his other on his



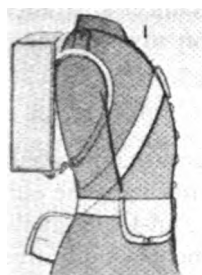
pouch—and what became of his musket !” The coatee was tight fitting, and the neck fettered by a tight collar with its leather stock—“an evil device which constricted the neck and tended to apoplexy” (Fig. 1).

#### THE OVERLOADED KNAPSACK

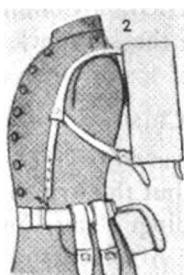
An indictment against a badly balanced load of about 60 lb., carried by soldiers during a long retreat, is given by Rifleman Harris, who was attached in person to Major-General Robert Craufurd during the Retreat to Corunna, early in the Peninsular War (December, 1808). He recounts that “the knapsack was our worst enemy in this prolonged march. Many a man died, I am convinced, who would have borne up to the end of our retreat but for the infernal load we carried on our backs. My own knapsack was my bitterest enemy . . . more than once I felt that I should die under its deathly embrace. The knapsack in my opinion, should have been abandoned at the very commencement of our retrograde movement . . . if by such loss we could have saved the poor fellows who died strapped to them on the road” (7).

Even during the Napoleonic era, discipline was not sufficiently rigid to prevent soldiers carrying in the knapsack and haversack loot and other spoils of war, which could hardly be covered by the term “Essentials” or even “Necessaries.” In the Memoirs of the French veteran Sergeant Bourgogne, written after leaving Moscow in 1812, we are told the following : “I spent some time in making an examination of my knapsack which seemed too heavy. I found several pounds of sugar, some rice, some biscuits, half a bottle of liquer, a woman's chinese dress embroidered in gold and silver, several gold and silver ornaments—amongst them a bit of the Cross of Ivan the Great—at least a piece of the outer covering of silver gilt, given me by a man in the Company who had helped in taking it down. Besides these, I had my uniform, a woman's large riding cloak (as I could not guess how it was worn, I imagined its late owner to be more than six foot high), then two silver pictures in relief, a foot long and eight inches high. I had besides, several locketts, and a Russian Prince's spittoon set with brilliants. These things were intended for presents, and had been found in cellars when the houses were burned down” (9). This truly amazing kit was apparently carried about by the intrepid sergeant for about a month, both on the march and into battle.

Whitehorne, in his *History of the Welch Regiment*, quotes as follows Sir William Butler, who wrote of the period preceding the Crimean War : “It was impossible not to love these old soldiers. They had so many splendid qualities. I call them old, in reality they were all under 40 years, but they were old in every other sense of the word. If you asked any of these men, when in hospital, what was wrong with them, they would usually answer—‘Only them pains, Sir,’ and if you asked what had produced the pains, they would invariably say it was the heavy belts and cumbersome pouches they had to wear for twenty four hours on guard. It was true, our stupid regulations broke down these fine soldiers long before their time.” Whitehorne quotes one of these old soldiers, a certain William Elcock of the 69th Regiment, who told him that “the knap-



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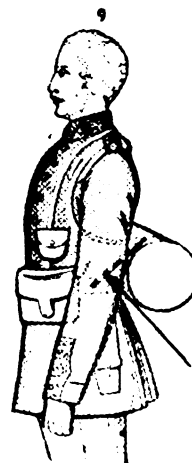


COL. O'HALLORAN'S

Note metal plates on  
back and chest: chest strap  
a combination of Berington's  
knapsack and Col. Spiller's  
metal rods



DR. PARKES'



SIR THOS. TROUBRIDGE'S

FIG. 3

Some of the equipments examined by the Committee of 1865-8 (metal parts shown dark). From War Office Confidential Papers.

sack with Field kit was always carried on Commanding Officer's parades and on Field days. I bear the marks of the knapsack straps on my shoulders to this very day "(10).

#### THE CRIMEAN WAR

During the time of the Crimean War (1854-1856), an attempt was made to improve the infantry equipment, but the British Army still wore the old pattern in Russia. In 1857 Colonel Hardinge (later Commander-in-Chief at the Horse Guards), president of the Field Artillery and Equipment Committee, wrote "The waterproof havresack has been recommended for trial, and has borne the test of use in Crimea with advantage . . . a tin water canteen, leather covered, to supersede the Italian wooden water canteen, has been ordered to be made and recommended for trial. . . . No article has been made generally so complained of as the wooden water canteen . . . leaky, weighty and pervious to heat in the extreme."

A contemporary description of the issue equipment of 1857 (Fig. 3) reads : "The cross belts and strap, with 40 to 60 rounds, are not only tight across the chest, but the pouch moves and bumps against the man's posterior. The shoulder straps of the knapsack cut the shoulders ; and swelling, weakness, and numbness of the arms or hands, lasting up to twenty four hours is common after a march. So great are the discomforts, loss of strength, and pressure on the nerves, muscles and blood vessels, that, all nations of Europe but ourselves, have of late altered the system of packs and accoutrements. Various propositions have been put forward for a number of years, but none have been adopted, . . . the present knapsack is worst of all, and if we cannot recommend an absolutely perfect one, there is no reason to be content with the present one" (11). It is obvious that "Pack Palsy" of the infantry soldier is no new disorder (56).

The Royal Commission of 1858 (12) brought to light the constant resistance by the military to innovation and improvement. As early as 1839, James Berington, a retired army veterinary surgeon, produced a knapsack clearly an improvement on its predecessors. After a number of troop trials, apparently successful, and in spite of the matter reaching the ears of the Director General, Army Medical Department (Sir James McGrigor), and Wellington himself, the equipment was turned down. In despair, Berington put forward his case in some detail in the *Lancet* of 1849 (13). Some time before 1858, the equipment again proved its value on trials, and it was praised by the Commission of 1858. Three years later, army surgeons Martin (14) and Moore (15) spoke highly of its value to the soldier. Nevertheless, the knapsack was never accepted, and soon forgotten.

#### COMMITTEE OF 1865-1868 : VALISE EQUIPMENT, 1871—PHYSIOLOGICAL TRIALS

The turning point in the history of personal load carrying equipment was reached during the period of 1865-1868, during which time there were four meetings of the Committee appointed by Lord de Grey. This *Committee Appointed to Inquire Into the Effect on Health of the Present System of Carrying*

*the Accoutrements, Ammunition and Kit of the Infantry Soldier* had as its president Major-General Henry Eyre, and the medical representative was a Dr. Edmund Alexander Parkes, the first, and recently appointed, Professor of Hygiene at the Army Medical School at Fort Pitt, Chatham. In the appendix to the first report we find a paper by Dr. McLean, Deputy Inspector-General, and Professor of Military Medicine at the Army Medical School at Netley.

Discussing the prevalence of disease of the heart and lungs in soldiers, he dismissed rheumatism and alcoholism as important factors, and came to the conclusion that the essential cause of these afflictions was the heavy load carried by the soldier, and the irrational method of carrying it. During the presentation of the paper, the heart of an old soldier was demonstrated, showing a white spot or "corn," which, the Professor believed, was not exceptional in old soldiers, and which he clearly ascribed to the pressure and friction of the cross-belts and chest strap of the soldier's equipment. A similar conclusion as to the cause of the "Soldier's Heart" had already been reached in 1862 by Sir William Aitken (16). However, it is nowadays well known that the "corn" or "milk spot" of McLean is in fact a manifestation of rheumatic heart disease, a disorder of young life, and in no way caused by the severe exertions or activities of the soldier. The Professor pointed out that he had discussed the matter of the soldier's load with numerous military medical officers, but very few had paid much attention to the matter.

During the first meeting in 1865 the Committee examined a large number of equipments, including the issue Prussian and French models, and decided finally that four equipments were worthy of trial. These were Lieut.-Colonel Sir Thomas Troubridge's yoke valise, Lieut.-Colonel Carter's plan, the Prussian pack, and a system devised by the Committee (Fig. 3). Large numbers of these four equipments were distributed to nine regiments, including Marines stationed at Woolwich, Chatham, Portsmouth and Plymouth. In August, 1867, a physiological trial was carried out by medical officers. Twelve men were used as experimental subjects, and pulse and respiration rates taken before and after a two hours' march wearing the various equipments, and before and after "a double" of 500 yards, with and without packs. A table of results is given in the Minutes of the Committee, but owing to changeable weather conditions (temperatures are recorded, but not relative humidity), and other uncontrollable factors, it is not possible to draw clear-cut conclusions as to differences between the equipments. During the troop trials, a series of 23 questions was given to the men using the various equipments, but a perusal of these suggests that it must have been sometimes difficult to give unbiased answers.

During the various lengthy discussions, the Committee put forward certain principles required of an ideal personal load carriage equipment. These were as follows: (1) The weight to be distributed over a wide area; (2) the weight of the knapsack behind to be balanced by the weight of the pouches in front; (3) all loads to lie as close to the body as convenient, and as near to its centre of gravity as possible; (4) no compression of the armpit or the chest; (5) the total load carried to be of the order of 45 lb. The equipment produced by

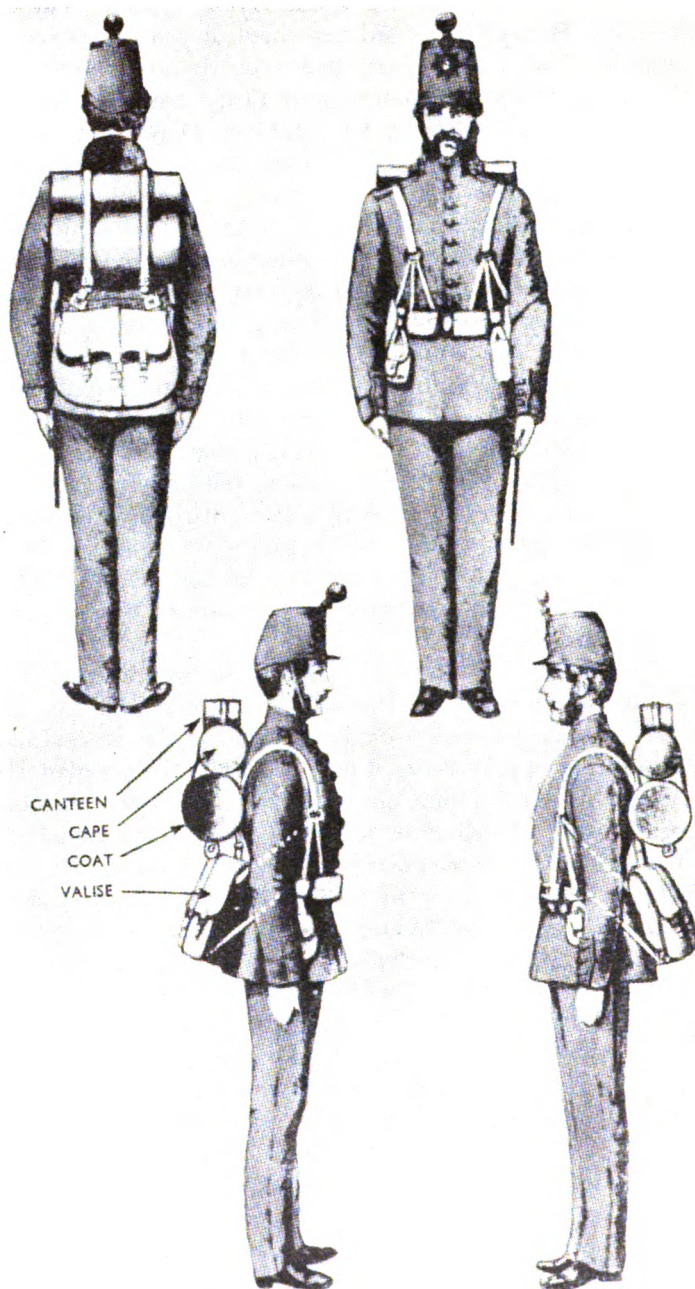


FIG. 4  
Valise equipment of 1871.

Professor Parkes had part of the weight thrown on the hips by two straight iron rods. The Committee's equipment was a modification of that of Troubridge, who in 1857 became first Director of Army Clothing at the establishments at Weedon and Pimlico, and who had been experimenting for some fifteen years on the problem of load carriage by the soldier. The original Troubridge valise plan was based on the principle of the milkmaid's yoke, the weight being again transmitted to the hips by metal rods. However, the Committee decided that metal rods in any form were unacceptable for military equipment.

The new equipment designed by the Committee received very favourable reports during the troop trials and answered the Committee's requirements. It consisted of a black waterproofed canvas bag or valise, worn over the small of the back, and supported from the shoulders by straps (Fig. 4). Pouches, straps and waist belt were pipe-clayed. The ammunition pouch was removed from its inaccessible position on the back, and replaced by two pouches (holding 20 rounds each) which, when filled, approximately balanced the contents of the valise behind. A further 30 rounds was carried in a ball bag. The load was thus borne by both the shoulders and pelvis; and in full equipment was so well balanced between the front and back that, it was claimed, the waist belt could be unbuckled on the march. There were no binding straps in the armpit, and the chest was at last completely freed from its constricting bands. An objection noted by the Committee was the large area of the back covered in Marching Order, with consequent poor ventilation and excess sweating. It was pointed out, however, that this defect had to be accepted, and with suitable adjustment of the side straps, sufficient ventilation could be obtained. For the first and last time in British military history the valise (or knapsack) was carried low on the back. We are told that "after several years' experience, the Committee believe that they have found the best, and perhaps the only, way in which military loads can be carried with perfect freedom to the chest."

In 1869 appeared the third edition of a textbook by Professor Parkes (11). This contained a valuable and enlightening section on the problem of marching and load carriage by the soldier. A detailed description of the new valise equipment was given, together with an analysis of various methods available for military load carriage. Parkes fully realized the importance of clothing and footwear in connection with personal equipment and load carriage; as well as the significance of foot hygiene, rest, sleep, food, training, climate and terrain, in relationship to the rate of marching and distance covered. In fact, there is little known nowadays of the problems of the marching soldier that was not well understood by this acute observer of Military Hygiene, whose work may be regarded as the most important in the early history of load carriage.

In the same year, letters appeared in the *Lancet*, by Assistant Surgeon Myers and Surgeon Major Robinson, dealing with the relative importance of organic disease, and heavy knapsacks, tight tunics and collars, in the causation of aneurysm of the blood-vessels in army personnel (17, 18). Although the observations appear somewhat naïve in the light of modern knowledge, they are nevertheless to be regarded as minor landmarks in medical history. The ideas of

McLean and Aitkin on the soldier's load as an important causal factor in the "Soldier's Heart" were soon refuted by a book published by Myers in 1870 (19) and by a report in the following year by Da Costa (20) of Philadelphia. The former based his conclusions on observations made on British troops in India, and the latter on cases studied during the American Civil War. Both showed that the commonest cause of so-called cardiac disease of the soldier was the "Irritable Heart," a disorder due, not to organic disease, but to the physical and psychological stresses of Service life. Strangely enough, this view did not receive general acceptance, and was forgotten for some forty years, to be rediscovered as "Disordered Action of the Heart" of the First World War and the "Effort Syndrome" or "Combat Exhaustion" (American terminology) of the Second World War.

The issue of the valise equipment was delayed by the trials of the new Martini-Henry rifle, and did not make its appearance till 1871. Nevertheless, we are told by a commentary in the *Lancet* of 1873 that "it is difficult to understand why there should be so much delay in replacing a portion of the soldier's accoutrements which is as unsuited to the present day rapid movement of war as Brown Bess (the fire-lock abolished in 1838) to a rifle range" (21). In 1876, Regulations still mention regiments in possession of the valise equipment, and others having the knapsack equipment (8).

#### VALISE EQUIPMENT ON THE CONTINENT

During the next few years the work of the English Committee and of Professor Parkes became well known on the Continent and in America. Morache, in France, in his textbook on Military Hygiene, published in 1874 (22), mentioned the current work of Judée on military accoutrements (23), and gave a complete description, including diagrams, of the British valise equipment—*le sac-valise anglais*. He described a trial of this equipment carried out by French troops, with very favourable results: "La poitrine se trouve complètement dégagée." Both Morache and Parkes were conversant with the dynamics of load carriage, with the work of the Weber brothers (24) and Meyer (25) on the mechanics of the human body, and the classic work of Duchenne (26) on the mode of action of the muscles of the body shown by electrophysiology.

Shortly after the appearance of the work of Morache, an important textbook on Military Hygiene was published in 1877 by the German hygienists Roth and Lex (27). This gave a long and detailed description of all military clothing and equipment of the period, both German and of other nations. As in the text of Morache, a great deal of space was taken up by the work of Professor Parkes and the British Committee of 1865-1868, and a detailed description with diagrams was given of the valise equipment of 1871. This was highly regarded, and in return for the compliment paid to the Prussian equipment in England, a trial was carried out on the valise equipment—*Die Englische Gepäck*—in Germany by a Prussian and a Saxon regiment, and with results similar to those obtained in France: "Die Brust durchaus nicht drückt, und das Schiessen im Liegen sehr bequem zulässt" (27).

## COMMITTEE OF 1879-1881: VALISE EQUIPMENTS OF 1882 AND 1888—TRIALS

In spite of the satisfaction expressed by the Eyre Commission with its work, the valise equipment soon came up for criticism, and during the period 1879-1881 there appeared two reports by another Committee on Equipment. The new president was now Major-General Steele. Professor Parkes had been replaced by Surgeon General McKinnon, and during the interim period Sir Thomas Troubridge had died. The Committee were asked to investigate the criticisms, and to examine carefully two new equipment designs that had been placed before them; one by a Colonel Barratt, and the other by Surgeon Major Oliver, whose plan had been praised in Canada. The two equipments were put out to trial together with the valise equipment, and the units concerned were given 23 questions to answer, similar to those used in the trials of 1865-1868. An objective test used during the trials was that of rifle fire, but the results were not appended and it does not appear that the accuracy of fire was measured. One notes with tolerance, tempered by experience, that the two units issued with Barratt and Oliver equipment gave completely contradictory opinions. Furthermore, a rift between the soldiers and physiologists made its appearance for the first time; and during the trials, Dr. Oliver made frequent complaints to the chairman, and later to the president, that his equipment was not receiving a fair test.

At the end of the trials, the Committee came to the conclusion that neither of the new equipments was suitable for acceptance, and recommended retention of the valise equipment, with the following modifications: (1) The valise to be of brown waterproof canvas, and to open at the back as recommended by Barratt; (2) the equipment to be made of brown leather; (3) the "havresack" to be carried in the valise; (4) the ball bag to be dispensed with; (5) in order to free the valise from the back, and to prevent the straps slipping down the shoulders, the supporting straps to be attached to the valise close to the mid line and below its upper edge (as in a rucksack) instead of to its upper corners. The following rider was added to the second report: "I do not agree with the Committee that the present valise equipment be retained for the present issue. I consider the principle faulty, and that the principle of Oliver, as modified, is far superior. Signed: Surgeon-General McKinnon."

In spite of the judgments of the two Committees, we find that a somewhat different personal load carrying equipment appeared in 1882. This was essentially the same as that of 1871, but the valise was now carried in its earlier position high on the back, with the great-coat below and the canteen (or mess-tin) in between. The pouches were flatter, set rather higher on the waist belt, and were pipe-clayed. As a natural consequence of this new position, supporting straps again passed through the armpit and the lateral view somewhat resembled the arrangement seen in the present 1944 equipment. The valise measured about  $15 \times 12 \times 3\frac{1}{2}$  inches, and had the disadvantage of not being detachable. In each pouch there were 40 rounds of ammunition.

By 1888 yet another improvement—known as the "Slade-Wallace" valise equipment—had appeared. The valise was now smaller, detachable, and the



armpit was freed of annoying supporting straps ; but it seems clear that the valise was not stable during "the double." Lack of supporting straps led to poor balance between valise behind and the pouches in front. The shoulders were pulled back, and stability could be obtained only at the expense of a very tight waist belt which was nevertheless dragged up on the man's stomach. At every halt, men could be seen hitching up the shoulders in an endeavour to get the pack in its proper place and the buckle of the belt down again. This fault, apparently absent in the 1871 equipment, was to be seen, and complained of, in most forms of British equipment which followed, even up to the present day. With the appearance of the Lee-Metford rifle in 1892, the number of rounds was increased to 100, equally divided between the two pouches.

#### END OF NINETEENTH CENTURY

Towards the end of the nineteenth century there was a determined effort in Germany to reduce the load carried by the infantry soldier. In 1894 a formal invitation was extended by the military authorities to the medical students and professors at the Frederick Wilhelm Institute to put on uniform and carry the campaign load of the infantry soldier. A series of marches was carried out, over distances up to 28 miles a day, in various weathers and with loads of 22-31 kilos. As a result of the trials it was concluded that, for the maintenance of health and efficiency, the total load carried should not exceed 22 kilos (48 lb.) ; and following a Cabinet Order of 1895, the weight was decreased from 31 to 27.8 kilos. These German trials are to be considered the first serious attempt to investigate the physiological background of the soldier's load.

During the period that work on load carriage was proceeding in Germany, Laveran, Professor of Military Hygiene at Val de Grâce in France, found time to write a textbook on Military Hygiene whilst continuing his renowned researches on malaria. This was published in 1896 (28) and, like its predecessors, gave an excellent analysis of the various factors concerned in the requirements of military clothing, marching and of load carriage. Laveran quoted the German trials, and gave a description with diagrams of the valise equipment of 1871. A great deal of reference was made to this text by succeeding authors, particularly in America.

#### *End of Part I*

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# A SHORT HISTORY OF THE DEVELOPMENT OF THE ARMY EMERGENCY RESERVE, THE TERRITORIAL ARMY AND THEIR MEDICAL SERVICES

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There is a history in all men's lives,  
Figuring the nature of the times deceas'd,  
The which observ'd, a man may prophesy,  
With a near aim, of the main chance of things  
As yet not come to life, which in their seeds  
And weak beginnings lie intreasured.

*King Henry IV, Part 2, III, i, 80.*

NOT all—and perhaps very few—of those who have joined the Army Emergency Reserve or the Territorial Army are aware of the long train of events which has gone to make these forces what they are today. Each has a long and honourable history and before coming to a description of their medical services it is desirable to know something of their evolution. In brief, then, the Army Emergency Reserve evolved from the Militia, through the Special Reserve and later the Supplementary Reserve, while the Territorial Army had as its predecessors the Volunteers, the Yeomanry and the Territorial Force.

## HISTORY OF THE MILITIA

Militia is a term generally used for organized military forces which are not professional in character and not permanently employed, the Latin derivation obviously being from *miles*, a soldier, *militia*, military service. All ancient armies with the exception of the personal guards of their leaders—which were the prototypes of regular or standing armies—were militias or national levies, remaining under arms for the period of the war, and returning to their civil employment when the war or campaign ended. In Western Europe the tribal militia system developed into feudalism. The nobles or knights spent a considerable proportion of their time in the practice of the warlike arts and constituted the officer class. Their tenantry—the rank and file—were only obliged to give a certain number of days' war service a year and no more.

In England the prototype of the militia was the Fyrd, also known as the General Levy. This was a force originated by King Alfred and continued by successive dynasties. Its function was to defend the realm against foreign invaders and also to suppress civil insurrection. In discharging the latter function it was repeatedly called out between 1066 and 1204 to suppress internal rebellion or to carry out border warfare against the Scots and Welsh. The

levy of each shire was first commanded by its alderman and after the time of the Conquest by the Sheriff. Every able-bodied free-man between the ages of 15 and 60 was liable for service.

After the Norman Conquest, King William I introduced the Feudal Levy, service in which depended upon tenure of land under the King as feudal lord. The holders-in-chief of large military fiefs from the Crown were the earls or barons, who in turn divided their domains into smaller military fiefs, the holders of which had the same obligations as the great tenants. These obligations were to attend the King at their own expense, on horseback and in armour, with their retainers. The knights on horseback served under the Feudal Levy, while the infantry were either the retainers of these knights, coming from the General Levy, or were raised by contract. The Feudal Levy was employed for service in continental wars, but was discontinued during the Commonwealth and abolished during the Restoration. Liability to service in the General Levy, however, has never been abolished.

In 1372 an Act of Parliament regulated the scope and limits of military service within the Kingdom, the cost to be borne by parishes and counties. Military service abroad, however, was chargeable to the Crown. Men and material for military service were raised by "Assizes of Arms," "Commissions of Musters" and "Commissions of Array." The Commissioners registered persons liable for service, sorted them into bands and trained and exercised them annually at the charge of the county. Hence the origin of the expression "train" or "trained bands." It is also interesting to note that the Commissioners of Musters became Lieutenants of counties, so appointed in 1549 by Edward VI. They were later made Lord-Lieutenants by Queen Mary and after the Restoration were appointed as Statutory Officers for the Militia, with the privilege of appointing officers but without any over-all control, this being vested in the King. Thus the General Levy became reorganized as the Militia, which had an obligation to carry out fourteen days' annual training, the cost being borne by the local authority. For nearly a century the Militia remained upon this footing, the supreme command being exercised by the Crown, but every precaution being taken by Parliament that this command should not be exercised in any unconstitutional manner. The Militia was, in fact, regarded as the army of the State, as distinguished from the Standing Army which was raised in 1661 and which was very much the King's personal army.

The Act of 1662, organizing the Militia, followed the old law requiring owners of property to furnish mounted and foot soldiers in proportion to the value of their property. In 1757 this was altered and each county was required to provide a certain number of men known as "The Quota." This total quota was subdivided down to parishes and each parish had to supply its quota by ballot. Exemptions were permitted in certain cases. Men chosen by ballot were also allowed to provide substitutes and volunteers were accepted. In 1852, however, the system was changed and the Militia became a volunteer force with the ballot kept only in reserve, either in case the quota was not filled by voluntary enlistment or in case of imminent national danger.

The rebellion of 1745 revealed grave inefficiency in the Militia, but not till 1757 was the force reorganized with a fixed period of service of three years and an age liability of from 18 to 45. In 1805 it was affiliated to the Line for the purpose of recruitment, and in 1813 nearly 100,000 militiamen joined the Regular Army. After the Napoleonic Wars the Militia fell almost into abeyance, but during the Crimean War it was again embodied, serving at home and also in Mediterranean garrisons, thus freeing regular troops. In addition it contributed over 30,000 officers and men to the Line.

In 1871 control was removed from Lord-Lieutenants of counties and vested wholly in the Crown, and in 1877 its officers were made subject at all times to military law. In 1881 it virtually became part of the Regular Army. It maintained its own reserve and special service sections, and this reserve could supply to the Regular Army in emergency one-half of the establishment of the Medical Staff Corps and different proportions to other corps.

This close affiliation led to what might have been expected. There was an increase of recruitment into the Regular Army and a gradual loss of the Militia character of the force, despite the fact that many Militia units served as such in the South African War.

When Lord Haldane was Secretary of State for War, one of the results of his reorganization of the Army was the passage of the Territorial and Reserve Forces Act of 1907. Under this Act the Militia was converted into the Special Reserve. This was a new branch of the Army Reserve which could also be joined by men who had not previously served in the Regular forces and its function was to supply drafts in the field to the Regular Army. In the 1914-1918 war the Special Reserve sent over two million officers and other ranks as drafts to the infantry alone.

In 1921 the title of Special Reserve was altered to that of Militia by the Territorial Army and Militia Act, but except for certain officers who had been commissioned before 5th August, 1914, and who were still retained, the Militia was not maintained in Great Britain or Northern Ireland.

In 1924 a new force, called the Supplementary Reserve, was formed under the Reserve Forces Act of 1882 and the Territorial and Reserve Forces Act of 1907. Although known as the Supplementary Reserve, it was in fact Militia. The Supplementary Reserve of Officers was designed for the following purposes :

- (a) To ensure that all units, services and departments of the Regular forces should be complete in officers on partial or general mobilization.
- (b) To maintain establishments in the Regular forces in war.
- (c) To provide officers for Supplementary Reserve units.

The desiderata for other ranks of the Supplementary Reserve were very similar.

During the First World War conscription was introduced in 1916 by the passage of successive Military Service Acts. The call-up was, however,

suspended in November, 1918, and the Acts came to an end on 31st August, 1921. After having been in abeyance for eighteen years, conscription was reintroduced in 1939, some months before the outbreak of the Second World War.

In 1947 conscription was continued under the National Service Act. The reasons for this continuance were (1) shortage of manpower and the need for a balance between industrial and agrarian requirements and those of the Services; (2) the failure to obtain a sufficient number of long-service volunteers; (3) the advent of new weapons and the power of delivering surprise attacks which allow no nation time to build up its forces.

Service was first limited to one year with the Regular Army and six years' part-time service. In 1949 this was changed to eighteen months' whole-time service and four years' part-time service. In June, 1951, whole-time service was extended to two years with three and a half years' part-time service.

Part-time service meant service either in the Supplementary Reserve or the Territorial Army. Officers and men who had completed their eighteen months or two years in the Regular Army were posted in their own arm of the service to Territorial Army units which were reasonably close to their homes. If this were not possible, or as Territorial Army units came up to their full strength, postings were made to the Supplementary Reserve. The Supplementary Reserve, in consequence, began to grow in strength and by the end of 1952 the total strength of the Army Emergency Reserve, as it had then become, was 91,809.

The latest chapter in a history stretching back to Saxon times was begun in September, 1952. On 6th September of that year Army Order 114 stated:

"Whereas it is provided by Sections 11 and 27 of the Army Reserve Act of 1950 that subject to the provisions of that Act it shall be lawful for Her Majesty by Order Signified under the hand of a Secretary of State to make, revoke and vary orders with respect to the government, discipline and pay of the Army Reserve. . . .

"And whereas by order of the 30th day of September, 1924, His late Majesty King George V was pleased to establish a branch of the Army Reserve known as a Supplementary Reserve for the Regular Army. . . .

"Now therefore, Her Majesty in exercise of the power conferred upon her by Sections 11 and 27 of the Army Reserve Act, 1950 . . . is pleased to order that the Supplementary Reserve shall in future be designated by the name 'Army Emergency Reserve.' "

By Army Order 115 of the same date the name of the Supplementary Reserve of Officers, a branch of the Regular Army Reserve of Officers, was to be designated the "Army Emergency Reserve of Officers."

The Army Emergency Reserve is divided into four categories, I(A) and II(A) and I(B) and II(B). All persons in Category A are required to carry out annual training in peace time. Those in Category B do not have this obligation. All volunteer and National Service officers and other ranks are posted to A except when specially notified to the contrary by the War Office.

All persons in Category A belong automatically to II(A) unless they voluntarily decide to undertake further liability by joining I(A). The liabilities of service in II(A) are as follows :

- (1) To be called out for permanent service when the Royal Army Reserve, or any part of it, is called out by proclamation, and in that event to serve in any part of Her Majesty's Land Forces in any part of the world ; and
- (2) To be called out on permanent service in the United Kingdom without proclamation in defence of the United Kingdom against actual or apprehended attack.

Any person who wishes to join I(A) undertakes the following additional liability :

- (3) To undertake in writing the liability to be called out for permanent service outside the United Kingdom when warlike operations are in preparation or in progress.

#### HISTORY OF THE VOLUNTEERS AND YEOMANRY

Voluntary military societies existed in various parts of England as early as in Tudor times. An interesting charter was granted by Henry VIII to "The Fraternity or Guild of St. George : Maistars and Rulars of the Science of Artillery as aforesaid rehearsed for long-bowes, crosbowes and hand gonnies." This guild later became the Honourable Artillery Company.

The idea of a large organized volunteer force, however, had its origin in the Militia Bill of 1757, which was amended in 1758 to allow Militia captains to accept volunteers instead of the militiamen which the parish or county were expected to furnish. This acceptance of volunteers for the Militia, or the buying off of a militiaman furnished by the parish, was recognized by Dickens, as is shown by the following passage from *Dombey and Son* : "If he could have bought him off, or provided a substitute, as in the case of an unlucky drawing for the militia, he would have been glad to do so on liberal terms." By 1778 the volunteers were still voluntary substitutes for the militiamen, but had organized themselves into separate companies of the Militia units. Soon after this, volunteer corps began to form themselves independently of the Militia, but were disbanded in 1783 and re-formed in 1794 in consequence of the French Revolutionary Wars. By the Act of 1794 the volunteers were exempted from service in the Militia.

The fortunes of the volunteers continued to fluctuate in direct ratio to threats from abroad, especially from the French, until a letter from the Secretary of State for War addressed to Lord-Lieutenants of counties on 12th May, 1859, authorized the passing of the Volunteer Act. This Act provided, amongst other things, for the permanent maintenance of the Volunteer Force in times of peace and for the calling out of that force provided invasion was apprehended, even though the enemy had not made an actual appearance. Although only designed

for protection of the country against invasion, during the Boer War one-third of the Volunteer Force served in South Africa of their own volition.

A parallel volunteer organization of mounted troops for the home defence of the United Kingdom was created in 1761, but was not properly organized till 1794. This was the Yeomanry, who were formed on a county basis, and both officers and other ranks provided their own horses. The strength of the Yeomanry fell after the end of the Napoleonic Wars, but during the Boer War 3,000 went to South Africa as mounted rifles, known as the Imperial Yeomanry. To these 3,000 were added 32,000 recruits.

After the Boer War came the usual period of apathy, and in 1904 a Royal Commission emphasized the fact that organization for war was almost non-existent. In 1906 the military forces of the Crown comprised the first line or Regular Army, the second line or Militia, and the third line composed of Volunteers and Yeomanry. The third line was separately organized from the other two and, owing to a disbelief in its value, was given no permanent place in any scheme for using the available military resources of the nation in the event of war. This was the situation which faced Lord Haldane and his advisers when they set about the task of reorganizing the British Army in 1906. The consequence of this reorganization was the passage of the Territorial and Auxiliary Forces Act of 1907. Lord Haldane, a Secretary of State for War whose services and foresight in reorganizing the British Army and its reserves on a sound and prudent basis were ill repaid by the British people, among other reforms united the Volunteer Force and the Yeomanry into the Territorial Force, the Yeomanry, however, retaining their old title.

With the passage of this Act the Special Reserve became a part of the first line or Expeditionary Force and the Territorial Force became the second line, organized to be a self-contained army in the same way as the Regular Army. Affiliated to the Territorial Force were Officers' Training Corps and cadet forces, the Haldane plan having as its express object the utilization of every sort of contribution to national defence. The original Territorial Force was intended for home service only, but the Act provided for individuals to volunteer their services overseas and, in fact, during the 1914-1918 war practically every Territorial Force unit volunteered for overseas service and whole Territorial Force divisions fought as such.

This force was organized on a county basis and county Territorial Force Associations were formed for each county under the presidency of the Lord-Lieutenant. The duty of these associations was to raise and equip the men, provide accommodation and generally relieve the units of all responsibility except training. The Secretary of State for War was responsible for training and formed a Territorial Directorate at the War Office for this purpose.

In the 1914-1918 war, fourteen Territorial divisions were overseas in 1915, while by 1918 twenty-one divisions were in various theatres of war and five divisions were constantly on home defence.

At the end of the war demobilization dispersed the Territorial Force, but it had proved its value to such a degree that it was re-formed in 1921 under the



Territorial Army and Militia Act and was henceforth called the Territorial Army. The reorganization which then occurred changed to some extent the terms of service. The old Territorial Force was liable for service in the United Kingdom only, but its members could, if they so desired, volunteer for service overseas.

In 1921 this was changed and the Territorial Army was constituted for Imperial Defence. Every officer and man was required to accept liability for service overseas, but could not be sent overseas until the passing of an Act of Parliament authorizing the dispatch of the Territorial Army abroad. The Territorial Army could only be embodied when the Army Reserve had been called up by Royal Proclamation in case of imminent national danger or great emergency, and the occasion must first be communicated to Parliament.

It was also laid down that if the Territorial Army was sent abroad, its personnel would not be used to supply drafts for the Regular Army, but would serve together as regimental units. If temporary attachments were unavoidable in emergency, the men so attached would be returned to their own units as soon as possible.

Recruiting improved by degrees, fell again in the early 1930's and grew from 1937 onwards when the country at last began to apprehend the threat of another world war. From 1935 onwards a new but gradually increasing commitment was given to the Territorial Army by the formation of Anti-Aircraft Command, almost exclusively manned by the Territorial Army. In 1941 Anti-Aircraft Command had grown to a force of twelve divisions. By the end of the war, Territorial divisions had taken part in every major campaign waged by the British Army.

In 1947 recruiting for the Territorial Army reopened very quietly. Those who volunteered, however, realized that soon the Territorial Army, as they might have known it before the war, would be a thing of the past, as by 1950 the volunteers would largely be diluted if not eventually swamped by the influx of National Service men who were required to complete their obligatory training in the ranks of the Territorial Army. None the less, it is felt that there are sufficient volunteers left to imbue the conscript Territorials with the old spirit of enthusiasm, and there is indeed much today over which the Territorial Army may become enthusiastic. At the end of 1952 the Territorial Army had a strength of 198,785 officers and other ranks, and this continues to increase.

All members of the Territorial Army, both volunteers and National Service men, have the following liabilities :

- (1) To be called out on permanent service in an emergency when the Territorial Army or part of it is embodied. When so called out, they are liable to serve in any part of the world.
- (2) To be called out on permanent service in the United Kingdom in defence of the United Kingdom against actual or apprehended attack, whether or not the Territorial Army is embodied.

## DEVELOPMENT OF THE REGULAR R.A.M.C.

In 1883, Evatt, in one of his many pamphlets, wrote : "During the century and three-quarters that the English Army has existed as a force, it has existed as a series of detached regiments until 1871. . . . Corresponding in every way to the military organization, the medical organization of the service was wholly regimental and remained so until 1873 when the departmental system was introduced."

In 1853 the Medical Services consisted of a grouping of medical officers commissioned by fours, threes, twos or singly to every battalion or battery in the Army. These officers wore the regimental uniform and were under the command of the battalion commander. In every garrison was a series of small battalion, regimental or battery hospitals, each separate and distinct, where the sick of individual units were treated by the unit medical officer. The Commanding Officer commanded the hospital, which was inspected daily by a subaltern.

The nursing was done by a regimental hospital sergeant and a certain number of privates of each battalion who were placed by the Commanding Officer for duty in the wards.

The hospital sergeant was the executive agent of the military commander to maintain discipline and see that the doctor's orders were carried out, as the doctor had no power of command over the sergeant, orderlies or patients. The same system applied to the Militia and Volunteers on embodiment.

If the regimental surgeon went sick or on leave he was replaced by a staff doctor, of whom there was a pool of 50-60. In 1854 there were in England no more than three general hospitals ; all the sick in each garrison were divided among the small regimental hospitals.

During the Crimean War the system of small regimental hospitals still obtained. There were no bearer companies, no field hospitals, no hospital ships and behind all was the chaos of Scutari. As a result of this, the Herbert Commission of 1857-8 introduced some improvements. It gave the doctors rank and pay ; it founded the germ of a hospital corps ; it formed two general hospitals to be training schools for war work, but it still maintained the error of maintaining the regimental hospital in peace.

It was not until after Sedan and Sadowa that progress was made. In 1873, due to the work of Sidney Herbert, later Lord Herbert of Lea, medical officers were removed from regiments, and staff and regimental medical officers were unified in the Army Medical Department ; regimental hospitals were abolished and replaced by Central Garrison Hospitals ; the Army Hospital Corps was formed for the performance of all hospital duties and the medical officers were made responsible for the control and management of hospitals in peace and war.

In 1877 command of the Hospital Corps was given to the doctors. The regimental medical officer was given sixteen regimental stretcher-bearers and a new organization, the bearer company, the forerunner of the field ambulance, was formed, four being allotted to a corps. Evatt, with great foresight, said :

"In any future wars it will be the most honoured and valued unit in the Army." Behind the bearer companies were to be field hospitals, twenty-five to a corps. We now see the kernel of the organization which is with us in modern times.

In 1898 the Army Medical Department and the Army Hospital Corps were unified in the R.A.M.C.

After the South African War the arrangements for the care of the sick and wounded were examined and reported upon by Royal Commissions and inter-departmental and War Office committees. Many changes in organization, training and administration took place. A new nomenclature of administrative appointments was introduced which remains with us to the present day.

Between the years 1904 and 1906 it was found that the Regular R.A.M.C. was quite inadequate in strength to provide the necessary medical units for an expeditionary force. In the South African War each brigade had one bearer company and one field hospital and each division one field hospital of 100 beds. These units were independent of one another. In 1901 a War Office committee recommended that the functions of a bearer company and the field hospital be combined in one unit—the field ambulance—which would cease to be a brigade unit. This came about in 1905.

In 1907, following reports from American observers of the Russo-Japanese War, a fresh review of the adequacy of the medical services to evacuate sick and wounded from the field ambulances to stationary and general hospitals on the line of communications took place and the question of providing sufficient beds in military hospitals at home was considered.

Because of this and similar reviews at subsequent dates and the steps which were taken in consequence, not only was no reproach ever levelled at the R.A.M.C. in either the First or Second World War, but the extreme efficiency of the Corps in carrying out its duties was highly praised by all Army commanders.

*(To be continued)*

## STUDIES ON URINARY CARRIAGE OF ENTERIC GROUP ORGANISMS

### VIII.—FLUID CULTURES OF URINE CONTAINING LARGE INOCULA AND FURTHER OBSERVATIONS ON URINE AS A MEDIUM OR INHIBITOR

BY

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It was shown in the seventh paper in this series (Archer, 1953*b*) that direct plating is commonly adequate for the culture of urine specimens from chronic persistent carriers, but may be less successful for routine carrier screening. Plates are also unsuitable for issue to be inoculated before sending to the laboratory.

Taylor (1947) mentions the use of tetrathionate broth followed by desoxycholate-citrate agar (D.C.A.) for urine culture in enteric. Archer and Ritchie (1950) attempted to evaluate tetrathionate broth, selenite, modified fluid MacConkey [MacConkey-mannite (MacC-M)] and urine itself as fluid media for enteric species. Archer, in the paper first mentioned above, reported MacC-M to be superior to direct plating for carrier screening and quoted Nagington as obtaining better results with selenite than with direct plating for this purpose. Anderson and Richards (1948) incubated mid-stream specimens from convalescent cases of enteric, and Andrewes and his colleagues (1920) recommended the incubation of a comparatively large volume of urine when organisms are scanty. The latter mention, however, that Morishima and Teague found that certain urines "inhibit" the growth of *Salm. typhi*, but that this is overcome by the addition of two volumes of broth. To afford selective action, the addition of 1 : 250,000 brilliant green to a duplicate broth culture is also recommended in their report. Nagington (1952) also considered buffered brilliant-green peptone-water a promising medium into which to inoculate urine for culture and transportation since *Proteus* is suppressed in addition to *Bact. coli*. The use and limitations of fluid media for urine culture, with special reference to MacC-M and to the inhibitory action of urine, are discussed below.

#### I. MACCONKEY-MANNITE

The medium was, in general, used at double strength and was inoculated with an approximately equal volume of urine.

##### *A. Growth and Fermentation in Negative Specimens*

Archer and Ritchie thought that the use of this medium should reduce subculture since cultures showing no evidence of fermentation might be discarded. It was recognized that an alkaline reaction, especially if gas was present, called for subculture, however, as alkali production by urea-splitting organisms might mask acidity caused by "sugar" fermentation. The presence of

non-enteric mannite fermenters in urine specimens, if common, would also greatly limit its usefulness. Neither of these two findings, however, was of such frequent occurrence in the routine clearance test earlier described as to invalidate the hopes previously entertained.

**Clearance Tests.**—At first both lactose (MacC-L) and mannite (MacC-M) media were used. The number of presumptive negative specimens (*i.e.*, specimens from which no *Salmonellæ* were isolated by any method) of which culture in both MacConkey fluid media is recorded is 375 ; of these, 173 (46.1 per cent.) were subcultured. Possible combinations of reactions in the two media, if degrees of acidity, alkalinity and gas production be taken into account, are very considerable and 72 were in fact observed. No useful purpose would be served by recording them in detail, but the most common combinations in order of frequency, and the number of times subcultures were made when they were found, are shown in Table I.

TABLE I

MacC-L	MacC-M	No. of times combination observed	No. subcultured	Notes
n	n	80	2	<i>Ps. pyocyanea</i> once found.
alk	alk	51	3	Lactose fermenters twice present.
AG	AG	30	29	Eight non-lactose fermenters, of which four fermented saccharose, detected.
n	A	17	15	Four lactose fermenters <i>growing in mannite only</i> ; two, no growth.
nG	AG	13	12	In one, lactose fermenters and <i>Ps. pyocyanea</i> both present.
n	AG	10	9	Three lactose fermenters <i>growing in mannite only</i> ; three non-lactose fermenters, of which one fermented saccharose.

A = acid, G = gas, alk = slightly alkaline, and n = neutral.

The total number of cultures showing some degree of acid in MacC-L was 71 ; of these 42 showed AG and the corresponding mannite of 7 was unfermented. The total number showing some degree of acidity in MacC-M was 161, of which 86 showed AG and 42 A. *Ps. pyocyanea* was isolated five times.

The 173 subcultures made yielded 97 lactose fermenters, 52 non-lactose fermenters (of which 24 fermented saccharose—while on six occasions lactose fermenters were also present), and 31 non-coliform organisms.

An indication that lactose fermenters were sometimes very scanty, and probably chance contaminants, is afforded by their being found seven times in MacC-M while apparently absent from the sample of the same specimen added to MacC-L, which remained unfermented (Table I). Conversely the seven fermented MacC-L cultures associated with unfermented MacC-M suggest a similar presence of lactose fermenters in the former and their absence from the latter.

MacC-L was omitted in 1,662 further tests on presumed negative specimens. 609 (36.6 per cent.) of these were subcultured ; 970 (58.4 per cent.) showed no evidence of fermentation or any alteration in pH ; 236 (14.2 per cent.), AG ;

197 (11.9 per cent.), A ; and 118 (7.1 per cent.) were strongly alkaline—74 (4.6 per cent.) without gas formation. *Ps. pyocyanea* was present 17 times and its presence in three other cultures was suspected. Seventy of a group of 128 cultures showing an acid reaction without gas yielded no growth on subculture. Their acidity was probably caused by the reaction of the urine inoculum, not by fermentation. Lactose and saccharose fermenters cannot be completely separated when considering organisms found after use of the lactose medium was stopped, since the D.C.A. plates used contained both sugars. Fermenters of one or the other (or both) were present, however, in at least 298 of the 609 cultures plated out.

The use of MacC-M in these series of examinations led to a 62 per cent. reduction in plating from 2,037 specimens. Lactose or saccharose fermenters were present in not less than 50 per cent. and *Ps. pyocyanea* in about 3 per cent. of the 782 subcultures which were made. The over-all incidence of these organisms in 2,037 persons' urine was thus not less than 19 per cent. and 1 per cent. respectively.

The reaction of the medium from which *Ps. pyocyanea* was isolated was acid 18 times (once only faintly so) ; this was generally shown to be due to other organisms also present : the medium was neutral three times (twice with gas) and alkaline (with gas) five times ; the additional presence of fermenters in the alkaline cultures was shown twice. *Ps. pyocyanea* was also cultured from 31 of the 534 persons in a series examined by direct plating and by culture after oxalate precipitation. It was found in 17 by the former and 16 by the latter. This organism was thus detected in specimens from 53 of 2,275 persons, an incidence of 2.3 per cent. Its presence may well have been missed in unfermented MacC-M cultures discarded without further examination, so this figure is probably low. As it stands, it is 50 per cent. above that found for enteric carriage, which was 35 (1.5 per cent.) (Archer, 1953b).

*The Possible Effect of Staphylococci in the Urine on MacC-M.*—Staphylococci were not specifically looked for and their presence was rarely suggested. The latter may have been partly due to the media used and to overgrowth, since it has been shown (Archer, 1938) that *Staph. albus* is relatively common in large specimens of urine. On that account, and since many coagulase-negative, as well as coagulase-positive, staphylococci ferment mannite (Evans, 1948), two strains of *Staph. pyogenes* were inoculated to MacC-M. One, a relatively weak mannite fermenter, was added in large and small numbers, suspended in water and in urine, to equal volumes of single and of double strength medium. Viability and growth in urine alone were also tested. In MacC-M the indicator showed no change to acid after several days. These cultures were kept and the pH tested some time later. One, from a watery inoculum, had a pH of 6.39. The other two, containing urine, were more alkaline than pH 8. This strain produced alkali slowly from urea. It was viable, and multiplied, in urine. Tests were then carried out on the Oxford strain, which seemed more active both in mannite fermenting and in urea splitting. Small and large inocula (five, 500 and 500,000 organisms approximately), suspended in distilled water and in 2 per

cent. urea solution, were added to equal volumes of double strength medium. Similar numbers were added in small volumes to the same medium. All cultures remained apparently neutral (as shown by the indicator) for 48 hours. The pH ranged from 6.80 to 7.07. Appearance of cultures showed that growth was not vigorous, and subculture of diluted medium containing the heaviest inocula showed more scanty growth than should have resulted from the inoculum alone. In another experiment the Oxford and a third strain produced some acidity (pH 6.44 and 6.39 respectively) in double strength MacC-M after 9 days.

It thus seems that staphylococci in a urine specimen are unlikely to have a confusing effect in MacC-M.

*Carrier Follow-up after Cure.*—Different effects in 139 MacC-M follow-up cultures on the carrier apparently cured by hexamine reported by Archer and Naylor (1952) were :

n	nG	A	Ag	AG	a	Alkaline
82	1	23	1	14	8	10

(where "a" and "g" represent slight acid and gas respectively, and other symbols are as in Table I). Actually, at least 113 cultures were subcultured, all, save one, with a negative result for *Salm. typhi*, but the neutral reaction on which rejection without subculture might have been based was thus present in 59 per cent. of all these specimens.

*Other Specimens from Non-carriers.*—Among the follow-up cultures on twelve persons passing schistosoma ova, antibodies or both, but who were not shown to be enteric carriers thereby (Archer *et al.* 1952), 73/87 (84 per cent.) gave no indication of fermentation in MacC-M. Lactose fermenters were found three times from cultures containing acid and gas. There were two other acid cultures containing gas, six acid cultures, and three containing gas but alkaline ; one, five and one of these were subcultured yielding *Ps. pyocyanea*, no growth, and no growth respectively ; 65 of the 89 direct cultures (73 per cent.) from these persons showed no growth, including all 35 cultures from five of them. The 65 sterile cultures comprised 39/51 (76 per cent.) from the seven who were passing ova (including all 20 from three of them) and 26/38 (68 per cent.) from the five persons in whose urine ova were not found (including all 15 from two of them) : six of the 24 positive direct cultures were *Ps. pyocyanea* from one case. Thus, though it seems likely (Archer *et al.*, 1952) that urinary schistosomiasis predisposed to chronicity of urinary enteric carriage, these results do not suggest that bacteriuria, unassociated with bacteriæmia, is more common in those with overt signs of schistosomiasis than in others. Five of 85 of the specimens, from the twelve individuals, cultured in selenite, yielded lactose fermenters.

*Attempted Modification to render the Medium Selective.*—Since 38 per cent. of routine screening cultures in MacC-M require subculture owing to signs of fermentation or alkalinity, and as alkaline reactions were then thought to point to an undue prevalence of urea-splitters (of which many are unaffected by the selective action of D.C.A.), modification of the medium was attempted.



*The addition of lithium chloride.* It has been shown by Gray (1931) that organisms vary in their resistance to lithium chloride and that this salt could be usefully employed for the isolation of enteric species from fæces, though its presence in MacConkey plates delays fermentation, and fluid media containing it require 48 hours' incubation before subculture. He found it more selective, but also more generally inhibitory, than brilliant green. *Ps. pyocyanea* was found especially sensitive to lithium, and he later (Gray, 1932) used it in strengths of 0.8 per cent. and 1 per cent. in Koser's medium to suppress that organism.

Preliminary tests on the suitability of lithium chloride as an added ingredient for MacC-M suggested that its differential action is better in MacConkey broth than in nutrient broth. Decreasing susceptibility was indicated for a strain of *Ps. pyocyanea*, a *Proteus* strain, a coliform organism and strains of *Salm. paratyphi A* and *C*, *Salm. typhi*, and *Salm. paratyphi B* in that order. The most selective concentration for enteric species seemed to be between 1 per cent. and 1.5 per cent.

A trial of its use at 2.5 per cent. (to be reduced to 1.25 per cent. by the addition of a urine inoculum of equal volume) in routine work was therefore proposed, while laboratory investigations were continued. These further investigations, however, eventually showed that the addition of lithium chloride may do more harm than good when added to MacC-M.

The following defects were revealed (Nagington, 1952) :

- (1) Variation in sensitivity of strains of *Salm. typhi* (not due to the diluting urine) so that growth of inocula up to 1,000,000 failed—or was retarded. *Salm. paratyphi A* and some strains of *Salm. paratyphi C* (but not *Salm. paratyphi B*) were also inhibited, while *Bact. coli* was not, and there was strain variation in respect of *Ps. pyocyanea* also.
- (2) Suppression of evidence of fermentation (confirming Gray's observations on solid media).
- (3) (a) Lack of turbidity in positive cultures.  
(b) Turbidity in negative cultures.

Lack of evidence of fermentation has, on occasion, proved to be a defect of the basic medium (see below). Lithium may possibly enhance it by a direct anti-enzyme effect or merely by retarding growth. Absence of turbidity in positive cultures is presumably due to retarded growth, confirming the need for 48 hours' incubation noted by Gray. Turbidity in negative cultures was apparently caused by interaction with salts in the urine. In view of these findings work on lithium chloride was stopped.

### *B. Observed Incidence of Mixed Specimens*

(Other organisms in specimens from enteric excretors)

#### *1. In Routine Carrier Screening*

In the carrier screening reported in the seventh paper in this series evidence

of the presence of other bacteria in the urine of enteric excretors varied with the methods used.

(i) *When MacC-L was used as well as MacC-M, subculture was to both MacConkey (M.) and D.C.A. plates, and primary direct plating was also carried out.* The specimens from two of the six excretors found under these conditions showed no signs of containing other organisms. The specimens from a third showed none in, or from, MacConkey media, but the primary plate was contaminated and *Salm. typhi* was not isolated from it. The last finding suggests that other organisms present exceeded the latter in number (being present in a loop inoculum while *Salm. typhi* was not), but that they were, to some degree, inhibited in the fluid medium and there overgrown by the pathogen. Lactose fermenters grew in the fluid media in the other three cases. In two cases they were only present in one medium. In two cultures they were found, with the pathogens, on plating out on M; in a third they were the only organisms isolated on that medium, the pathogen being missed, though present on D.C.A.; in one MacC-L the presence of lactose fermenters was indicated by acid and gas, though they were not isolated on plating: they did not appear on D.C.A. plates inoculated in parallel with the M. plates on which they grew. The direct plates from one of these three cases were enteric-positive; the other two were contaminated, and negative for the enteric organism.

These results suggest that coliform contaminants may be very scanty, as they were absent from large inocula 2/6 times; and that D.C.A. may be better than M. for subcultures from fluid MacConkey—though the above-recorded failure of M. was balanced by a failure of D.C.A. when the corresponding M. plate showed a few colonies of *Salm. typhi*.

(ii) *When MacC-L was omitted, MacC-M plated on D.C.A. only, and primary plating also carried out.* Of fourteen isolations made under these conditions eleven showed no evidence of contamination in MacC-M or on D.C.A. subculture plates; of the corresponding eleven direct plates, six were positive, two sterile, and the remaining three negative, but not recorded as sterile. The only finding which might suggest contamination in two other cases was alkalinity of the MacC-M; direct plates were positive and sterile respectively. The fourteenth case showed no sign of MacC-M contamination, but the direct plate was contaminated, and negative for the pathogen. In a fifteenth case the MacC-M yielded only fermenters on D.C.A., though the direct plate was positive.

(iii) *When MacC-M only was used.* There was no evidence of contamination (except alkalinity in two) of eight positive cultures so found.

## 2. In an Investigation of an Outbreak

*Salm. paratyphi C* was isolated repeatedly from one, and *Salm. paratyphi A* once from another, foodhandler in this investigation. Three positive specimens from the former case showed evidence of contamination in fluid media when MacC-L, and M. plates, were in use; *i.e.*, alkali and gas in MacC-L twice, though MacC-M gave a pure culture of *Salm. paratyphi C* both times; and

lactose fermenters isolated from MacC-L once, when fermenters were also isolated on D.C.A. from MacC-M. All three direct cultures were contaminated, though one was also positive. Of three later cultures in MacC-M plated to D.C.A. only, two showed no sign of contamination; the third yielded fermenters on D.C.A. The *Salm. paratyphi A* cultures showed no sign of contamination. MacC-L and M. plates were used as well as MacC-M and D.C.A.

### 3. In Follow-up Cultures on known Carriers

(i) *Lactose-fermenting coliforms*. Thirty-nine of 59 consecutive MacC-M cultures on seven chronic persistent carriers (Nos. 1, 2, 4, 5, 9, 10 and 19, Archer *et al.*, 1952) were positive for the carried species on subculture to D.C.A.; in only four were lactose (or saccharose) fermenters also found. Lactose (or saccharose) fermenters were also present in three (and possibly in two more) of the negative cultures. While this fluid medium (unlike selenite) allows free growth of coliform species, the chances of their successful subculture was, as shown above, reduced by D.C.A.; there is, however, other evidence of their rarity. Firstly, 38 of the 59 direct cultures made at the same time as the above-mentioned were positive for the carried species; in only one of these were lactose fermenters also detected on the M. plates used. Secondly, the gas which should normally be produced if coliforms were present was rare in MacC-M inoculated with the urine of carriers of *Salm. typhi*; it was not found in positive cultures from carriers No. 1 and No. 2 (though present in three negative cultures from the latter) and it was present only once for each, in positive cultures from carriers No. 4 and No. 10 (not including two among 154 positive cultures from the latter during, and between, treatments). Finally, a viable count was made on an earlier specimen from carrier No. 4 when a few coliform organisms were present; the coli/*typhi* ratio was approximately 1/1000 (1,000 coliform and 1,000,000 *Salm. typhi* respectively per ml.).

(ii) *Ps. pyocyanea*. This organism was found twice in MacC-M cultures from carrier No. 10. In one of these it may have prevented the isolation of *Salm. typhi* also present in small numbers, since a selenite culture was positive, though the direct plate was also negative for the latter. In the other instance *Salm. typhi* was not detected at all. *Ps. pyocyanea* was also found in a MacC-M culture from carrier No. 2. Here also *Salm. typhi* was not found by any method.

(iii) *Non-coliform organisms*. Such organisms were isolated from seven of the 59 MacC-M cultures mentioned above—but never with the enteric species. Direct culture yielded them five times—but only once together with enteric organisms. The above isolations all occurred, of course, in bile-salt media. Viable counts on chronic carriers, however, were often made on nutrient agar—yet they generally showed a pure, or almost pure, growth in the higher dilutions. Sometimes, though, a diversity of species was shown by the presence of two or three different colonial forms. Carrier No. 20 once passed 9,000 organisms other than *Salm. typhi* per ml. in a specimen containing 30 million *Salm. typhi* per ml., a viable count on carrier No. 28 showed 3,000 *Salm. paratyphi A* and

350 non-enteric organisms per ml., and more than 50 per cent., approximately 50 per cent. and about 25 per cent. of such contaminants were found in specimens

TABLE II.—REACTIONS IN MACCONKEY-MANNITE FOLLOWING INOCULATION WITH URINE OF CHRONIC CARRIERS

Carrier No.	Positive Specimens						Negative Specimens							
	Total	Number producing					Total	Number producing					No. with no record of results	
		Appropriate effect	Very weak effect	No Acid		Failure of normal gas, though acid		Presence of abnormal gas	No effect	Acid	Acid and Gas	Gas only		Alkali
				Gas +	Gas -									
1	16	15 (acid)	1				7	1 (a)	5	1				
2	8	8 (acid)					17	3	10 (b)	3 (b)			1	
4	15	14 (acid)	1 (c)				5		3	2 (d)				
5	13	8 (acid and gas)		1	1	3	4		2	1	1			
9	14	9 (e) (acid and gas)		1		4	8	1	1	5(f)			1	
9*	99 (g)	94 (acid and gas)		1	2	2								
10	16	14 (acid)	1 (c)				7		4 (d)			3 (h)		
10*	155 (g)	150 (acid)	2		3 (k)									
19	4	4 (acid and gas)												

\* When under treatment.

#### NOTES ON TABLE II

- (a) Probably a false negative. It was not subcultured on account of the absence of acidity, but both direct plating and selenite were positive.
- (b) The corresponding direct cultures of five sterile acid cultures, and of one sterile culture showing acid and gas, were positive. (See Death in Culture, below.)
- (c) The medium contained lithium chloride. (See above.)
- (d) In one, organisms isolated by all three methods were inagglutinable.
- (e) One late : at first slightly acid only.
- (f) Four were sterile. Three of these were positive by other methods. (See Death in Culture, below.)
- (g) Most were "presumptive"—based on reaction and on the presence of the pathogen on direct plates.
- (h) All contained gas. *Ps. pyocyanea* from two (including one negative by direct plating, but positive by selenite).
- (k) One during hexamine treatment ; only 46 colonies on subculture. The other two during, or just after, sulphanilamide.

from carriers No. 2, No. 19 and No. 21, containing 20 million, 90,000 and 2 million organisms per ml. respectively.

#### 4. Recent Results

More recently Nagington (1953) recorded the incidence of other organisms, in addition to the enteric species present, among 20 positive cultures in MacC-M from different individuals. Seven were so contaminated, comprising two *Salm. paratyphi B* cultures which also contained coliforms, three *Salm. paratyphi A* cultures containing coliforms and one in which *Ps. pyocyanea* was present, and

a culture of *Salm. typhi* contaminated with staphylococci. The other 13 were apparently pure enteric cultures.

Finally, it should be noted that Browning *et al.* (1933) refer to the occasional occurrence of coliform bacilluria in pure culture in enteric fever.

### *C. Growth and Fermentation in Cultures from Positive Specimens*

#### *1. Failure of Fermentation*

*Screening tests.* In achieving the reduction in subcultures referred to under Section A above, reliance was, of course, very largely placed on absence of signs of fermentation of the medium (though this was often reinforced by an absence of turbidity). Hence it must be noted that :

(a) Though a higher proportion of positive results was obtained by this method in routine screening than by direct plating, acid, or acid and gas, was only present in 21 of 29 positive cultures recorded in the seventh paper in this series (Archer, 1953*b*). Of the others :

(b) Two of the eight positive typhoid cultures showed no signs of fermentation (one even after 48 hours) and so would have been missed by a rigid routine exclusion of all such cultures from further examination.

(c) Three cultures of *Salm. paratyphi A* and one of *Salm. typhi* were alkaline (the latter and one of the former only weakly so), thus emphasizing the need, which was accepted by Archer and Ritchie (1950), for subculture when this reaction is noted.

(d) Two cultures of *Salm. paratyphi C* showed gas only, in a neutral medium.

(e) Thus, in this series, "correct" reactions were shown by only 9/14 *Salm. paratyphi A* (though two others showed acid without gas), 5/8 *Salm. typhi* and 3/7 *Salm. paratyphi C* (though two others showed acid without gas). The three defects in respect of *Salm. typhi* were of a nature to bring about a failure in isolation if subculture were selective and not general.

*Follow-up cultures on known carriers.* Fermentation failure and other irregular results are shown in Table II, which shows that characteristic evidence of fermentation was absent in three of 55 cultures of *Salm. typhi* (and in one other which was probably positive though missed), and in ten of 31 cultures of *Salm. paratyphi A*. Among the latter, however, seven merely showed an absence of gas, only three being potential failures of the method on account of neutrality. To these should probably be added one which might have been missed, as characteristic fermentation was delayed. Apparent failure of fermentation was thus observed only eight times in 87 cultures (9 per cent.) on primary follow-up of chronic carriers. The cultures carried out while carriers Nos. 9 and 10 were under intermittent treatment are not included in the above summary. Failure of fermentation liable to give rise to failure in isolation occurred nine times among 254 positive (or presumed positive) tests then carried out. MacC-M cultures containing the two positive specimens passed by carrier No. 20 after treatment also remained unfermented. Seven of these eleven

failures were complete; nine, however (including five complete), occurred among 24 tests performed while, or just after, a course of treatment was actually in progress.

*Recent screening results.* In view of the possible danger of missing carriers if reliance is placed upon obvious fermentation of mannite, the recent practice has been to subculture all MacC-M cultures irrespective of their appearance (Nagington, 1953). Nagington found that, among eleven positive *Salmonella* cultures, including six *Salm. typhi* and two *Salm. paratyphi A*, in this medium, two were not acid. Both of these were cultures of *Salm. typhi*. One of these two was alkaline, but the other was neutral and hence would have been missed if reliance had been placed on change in the indicator present. A parallel series of tests showed this medium and a brilliant-green peptone-water to be almost equally effective when all primary fluid cultures are subcultured.

## 2. Very Rapid Death in Culture

In the fifth paper in this series (Archer, 1953a) death, by the third day, of five of eight paratyphoid cultures in glucose media, and one of eight such cultures in mannite media, is recorded. (None of these cultures was dead after one day or—with one apparent exception in glucose—after two.) Death seemed solely due to acidity produced in the medium by fermentation. This was generally less in mannite than in glucose media.

As recorded in the seventh paper in this series, however, fluid cultures showed a particularly low isolation rate compared with direct plating in follow-up cultures from carriers No. 2 and No. 18. In selenite culture, as well as in MacC-M, urine inocula were relatively large.

The findings in MacC-M were peculiar:

*Carrier No. 2 (Salm. typhi).* (a) Five MacC-M cultures which were sterile on plating were acid; all direct plates from the same specimens were positive (see note (b) to Table II): selenite cultures from four of these specimens were also sterile.

(b) One MacC-M culture which was sterile on plating was neutral: the selenite culture was also sterile, but a single colony was present on the direct plate.

(c) In the primary screening at which this case was found there was no growth on D.C.A., and only a few colonies on M., from MacC-M (as already recorded). The MacC-M was neutral. The direct plate and selenite were contaminated, the latter with a saccharose fermenter.

(d) One acid MacC-M culture yielded only a single colony on subculture, though both selenite and direct plate of the specimen were positive—with considerable growth on the latter. (In two other instances subcultures from selenite inoculated with different specimens yielded only 8 and 5 colonies respectively on subculture, though direct plates of the same specimens showed numerous colonies.)

*Carrier No. 18 (Salm. paratyphi A).* (a) Five MacC-M cultures were sterile on plating though showing acidity and gas in the medium: the corre-

sponding direct plates were positive : two of the selenites were also sterile, and a third produced only 5 colonies on plate subculture.

(b) Four other MacC-M cultures in which acid and gas were present showed only 3, 2, 16 and 10 colonies on subculture plates : two of the corresponding direct plates bore numerous colonies, another a moderate growth and the fourth scanty growth respectively, while selenite produced a scanty growth, nil, 2 colonies and 1 colony, on subculture.

(c) Tests of strain viability in selenite and MacC-M by addition of inocula of about 10, 100 and 1,000 organisms of the carried strain to each showed no evidence of inhibition or of abnormal sensitivity of this strain to either medium.

A primary (screening) culture in MacC-M from another excretor of *Salm. paratyphi A*, in which acid and gas had been produced, yielded only 3 colonies on plating out, though the primary direct plate was positive.

## II. URINE AS A MEDIUM

The findings last described might be explained as follows :

(i) Acidity might have been due to an acid inoculum in which there were, however, no viable organisms. This is unlikely in view of the positive direct plates from the same specimens.

(ii) Gas in the cultures from carrier No. 18 most strongly suggests that viable bacteria had, for a time, lived and multiplied, but later died. It seemed just possible, though, that a very large inoculum of organisms dead, but containing enzymes which were still active, might give rise to "sugar" fermentation with gas production.

That this is the true explanation of the observed effects is, apart from its intrinsic improbability, unlikely since in four cultures organisms were not all dead, but the small numbers alive suggests that the culture was dying. The selenite cultures from the same specimens showed the same sign of dying out.

(iii) The true explanation would therefore seem to lie in a slowly lethal action of the urine of the inoculum. On plates this could be annulled by diffusion of the small volume used. In fluid cultures, when a large amount is inoculated, such action may continue. It may perhaps also be enhanced by products of bacterial metabolism.

(iv) Our findings suggest that urine having such properties is frequently passed by certain individuals and rarely or never by others.

The above conclusions seem to support the findings of Morishima and Teague (Andrewes *et al.* 1920) that certain urines inhibit the growth of *Salm. typhi* (though it is not clear from the report quoted whether these workers demonstrated a killing effect or merely a failure of growth, *i.e.*, that some urine was a bad medium). The viability of *Salm. typhi* (901-H) at 37° in single specimens of urine from seven Europeans and 26 specimens from 25 Egyptians (or Sudanese), 33 specimens in all, and the value of the specimens as media, was tested. A falling series of inocula were used. The inoculated specimens were incubated for 48 hours, and examined after 24 and 48 hours for turbidity.



Broth was then added to cultures which were still clear to ascertain whether the added organisms were still alive. Parallel tests were made on Seitz filtered urine samples and on samples heated at 55° C. for 4 hours.

*Specimens from Europeans.*—Only one was a really good medium (showing good growth from a small inoculum in 24 hours). None were lethal, and, had they been carriers' specimens containing a few pathogens only, all could have been incubated alone with advantage. In one case the filtered urine, in another the heated, produced better growth than the other sample.

*Specimens from Egyptians (or Sudanese).*—Five were really good media. One of the samples from five others (three heated, two filtered) was also good. Two (8 per cent.) were highly lethal (or intensely bacteriostatic), no growth occurring after addition of broth to the four samples inoculated with 500,000, 5,000, 12,000 and 12,000 organisms respectively, 48 hours before. With sixteen specimens there was a difference between the heated and filtered samples; in nine cases the former, and in seven the latter, was the better. In five of these instances (in four of which the heated sample was the better) the difference was marked, including one in which the heated urine was a good medium, but the filtered highly inhibitory, though non-lethal. Results suggest that, had these men been carriers passing scanty pathogens only, incubation of the urine of 19 of them (and possibly a further four) alone would probably have been useful.

These tests unfortunately preceded tests on the effect of acidity on bacterial viability (Archer, 1953a), hence pH of these urines was not tested. Later, the pH was taken of urine samples from 71 Egyptians, Sudanese, Eastern Europeans and Levantines submitted for carrier testing. Eight (11 per cent.) of them passed specimens of pH 5.2 or of higher acidity, details being as follows: pH 5.2, three persons (one of two specimens from each of two; a single specimen from a third person): pH 5, three persons (both of two specimens from each of two; one of two specimens from a third person): pH 4.8 and pH 4.73 each from one person (a single specimen, and one of two, respectively). This incidence may be compared with the 8 per cent. incidence of lethal urine samples found. It should also be noted that Coombs, Catlin and Reader (1937) have shown that persistently high urinary acidity may be induced by diet alone. By suitable feeding they were able to keep the reaction of two-hourly specimens at, or below, pH 5.3 for 3 days. Their illustrative figure indicates that on the third day pH 4.9 was reached several times, while in the 3 days there was no evidence of alkaline "tides." Urine may contain various buffer systems and, as pointed out by Coombs and his colleagues, dilution with distilled water may have little effect on pH. It may be, then, that dilution even with fluid medium may not counteract the adverse effect of the urine in a very large inoculum.

### III. DISCUSSION

The use of a fluid medium would appear to improve the chance of successful isolation of enteric species from urine, and such a medium is obviously convenient as a vehicle for the transmission of specimens. The addition of mannite and

an indicator has generally been considered to justify discarding unfermented cultures without further examination. Nevertheless, two unexpected and unwelcome findings have shaken our confidence in this practice. They are :

- (1) Failure of the pathogens to produce obvious acid from mannite. This is most serious in *Salm. typhi* cultures in which the additional warning sign of gas production is absent.
- (2) Rapid death in culture in both MacC-M and selenite.

The following hypotheses are advanced as possible :

(a) Both effects are caused by the buffer properties of the urine inoculum. Failure of obvious fermentation in a living culture would then be due to an alkaline or neutral urine inoculum which has a sufficiently large buffering capacity to prevent a noticeable change of  $pH$  from the acid produced by fermentation of carbohydrate. Specimens from two of the 71 Egyptians, etc., already mentioned were neutral, and three were slightly alkaline ( $pH$  7.2,  $pH$  7.2 and  $pH$  7.8).

On the other hand, early death of a culture would, on this hypothesis, be due to an acid urine of high buffering capacity and the resultant low  $pH$  of the urine-medium mixture. In MacC-M the  $pH$  might be lowered further by the products of fermentation. Death in selenite is not so easily explained since, when using the usual formula, no further acid should be produced. If the reaction of the urine is so acid as to render it highly lethal, death of the organisms might be expected in the bladder and the passing of viable organisms on micturition requires explanation. These might be produced from an infected focus in the bladder wall by extrusion during the act of micturition (possibly accompanying schistosoma ova also extruded). Such organisms would be passed immediately after entering the bladder and would remain in contact with the urine there only for a short time, though in such circumstances the numbers excreted would presumably be small.

(b) Lack of obvious acid is due to a balance between acid production by pathogens and alkali production by coincident urea splitters preventing a noticeable change in  $pH$ .

(c) Failure of acid production is due to other inhibitors in urine which prevent the pathogens from multiplying or fermenting, but leave enough viable organisms to yield a positive subculture from a loop (acid inhibition is obviously not applicable in this case). The very large numbers often passed by urinary carriers (Archer *et al.*, 1952; Archer, 1953*b*) would allow for this, but it seems unlikely unless due to a drug, as in certain cases described by Archer and Naylor (1952).

Alternative hypotheses to account for very rapid death in culture are not put forward. Death of the enteric pathogen could conceivably be due to antibiotic action of coincident organisms, *e.g.*, "colicines" produced by coliform bacteria (Gardner, 1950). Such action may perhaps explain some failures of isolation from carriers. Browning *et al.* (1933) considered that a relative failure of brilliant-green media compared with direct plating of fæces was due to direct

antagonism between the carriers' strains of coliform organisms and *Salm. typhi*, but results obtained by other workers (Halbert and Magnuson, 1948; Heatley and Florey, 1946) suggest that failures of isolation due to antibiosis are more to be expected on solid, than in fluid, cultures. Antibiotic action, however, seems unlikely to cause apparently *sterile* subcultures. To do so the antibiotic-producing species growing in the primary fluid culture would have to be very effectively inhibited by D.C.A. Self-sterilization of the culture by the action of phage also present in the urine (suggested as possible by Archer *et al.*, 1952) is also improbable, especially when signs of fermentation bear witness to early growth. Such growth would suggest that, if a phage had been introduced with the inoculum, mutants resistant to it were already present, or had developed.

Experiments to test the hypotheses advanced are at present in progress and will be reported in a later communication, though it may be stated here that no support for any of them has as yet been found. Meanwhile, until the causes of death or failure of acid production are known, it is clear that MacC-M should no longer be used in the manner originally intended. It is doubtful whether mannite should be incorporated in a fluid medium of such inadequate selective action; indeed, the acid produced by its fermentation may do positive harm.

#### IV. SUMMARY AND CONCLUSIONS

1. Use of a fluid medium for urine culture for enteric organisms is desirable when organisms are scanty, and as a vehicle in which to convey specimens to the laboratory.

2. While the addition of a differential "sugar" (such as mannite in Mac-Conkey-mannite) has, in practice, curtailed subculture by 62 per cent., lack of evidence of fermentation in positive cultures, including 5 of 14 of *Salm. typhi*, has shown that this economy is unjustified. Possible explanations of this finding are discussed, but until the true one is found, and unless the explanation suggests the remedy, all fluid cultures must be subcultured. This conclusion removes the reason for the presence of a fermentable substance in the medium used.

3. Urine is commonly an adequate medium, but may be inhibitory. Enteric species sometimes die very rapidly in fluid culture of urine even when early growth is suggested by fermentation in the dead culture. This seems to occur often in cultures from certain individuals, and not in those from others. The causes of these adverse effects are discussed: both might be generally due to acidity of the urine, though apparent growth-failure or death in two neutral mixtures of MacC-M and of samples of urine from one typhoid carrier is recorded. They seem to indicate that dilution of the urine with medium should be beyond one in two. One in four is suggested for trial.

4. The incidence of organisms other than enteric pathogens in the urine of carriers and others is recorded. They do not seem to be very common in carriers' specimens and such as occur appear likely to be relatively few in number. The use of selenite or other special enrichment media is thus probably unnecessary. The presence of sodium taurocholate in the medium to limit

growth of non-intestinal organisms seems, however, desirable. In non-carriers the incidence of lactose or saccharose fermenters was not less than 19 per cent. There was evidence, however, that they were sometimes very scanty, and probably chance contaminants. *Ps. pyocyanea* was found in the urine of 2.3 per cent. of non-carriers. The addition of lithium chloride to MacConkey-mannite to inhibit coliforms, *Proteus* and *Pseudomonas* was tried without success. The contraindications included differences in strain sensitivity both of enteric species (normally resistant) and *Ps. pyocyanea* (normally susceptible), which became apparent. With general subculture, in a comparative series, isolations from brilliant-green peptone-water and from MacC-M. were about equal.

5. It is suggested that, pending further studies on the possible causes of poor and anomalous results with methods here, and previously, described, and their possible prevention, fluid urine cultures should be made by diluting the inoculum 1/4 in broth or peptone water containing sodium taurocholate and possibly also brilliant green. The medium might be buffered, or perhaps preferably contain an indicator such as brom-thymol blue, which would allow adjustment of the reaction to neutral if suggested by a colour change after inoculation.

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# PSYCHIATRIC CASUALTIES IN U.K. ELEMENTS OF KOREAN FORCE

DECEMBER, 1950—NOVEMBER, 1951

BY

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## INTRODUCTION

THIS short paper has been written mainly to give an account of the psychiatric breakdown in U.K. troops engaged in Korea during the twelve months from December, 1950, to November, 1951. It includes also a short analysis of psychiatric casualties among the Australian, New Zealand and Canadian members of the Commonwealth forces who also came under our care. It does not include the R.N. and R.A.F. personnel referred for psychiatric opinion and disposal as there were so few that they have no statistical importance in this survey. It will be remembered that the Korean War started in June, 1950, and within a short while British troops were actively engaged in fighting the North Koreans. In November, 1950, the 29th British General Hospital arrived in Kure, Japan, to serve as a base hospital for the Commonwealth members of the Korean Force. By this time the 28th Brigade, which had been dispatched from Hong Kong and supplemented by an Australian battalion, was already an active fighting unit. The two U.K. battalions were two well-integrated units who had trained together in the New Territories adjacent to Hong Kong. It is worthy of note that on arrival in Japan there were but a few psychiatric casualties awaiting disposal even though the Brigade had been in a considerable amount of combat. About the same time as the arrival of the hospital the 29th Brigade was ready for action, but had not as yet actively engaged the enemy on a large scale. This Brigade was in the main one of reservist soldiers, all somewhat discontented with their recall, and it was clear that there was a high potential psychiatric breakdown within this member of the force. The majority of the reservists were men who had joined the Regular Army in the immediate pre-war years and had seen a considerable amount of active service, and when reverting to civilian life, though still on Class A Reserve, were physically and mentally fit. It was to be expected therefore that the vast majority were relatively mature, stable personalities capable of making a good social adjustment to their environment, and with combat experience behind them they were in possession of a fair measure of security. Indeed, these traits were present but were offset to some extent by the understandable resentment and hostility of being recalled. Reservists were a considerable problem over the first few months and, though presenting with anxiety symptoms often unrelated to battle, they had sufficient insight and judgment to know what was expected of them. Many such cases

precipitated by domestic upheavals and home worries were most adequately dealt with by Welfare Authorities.

The base hospital was structurally comfortable and adequate for our needs, comparing only too favourably with the harsh environment of Korea. In general it may be said that the Psychiatric Centre was "too far back" and if suitable accommodation could have been found in Korea itself it would have been easier to deal with those cases of mild to moderate severity in which a R.T.U. was considered worth while. It may be truthfully said that the psychological resistance to a R.T.U., whether conscious or unconscious, is inversely proportional to the distance of evacuation from the battle front. In August, 1951, a clinical officer in psychiatry was attached to a Canadian F.D.S. with good effect. This prevented the unnecessary long-distance evacuation of personnel purely for psychiatric opinion or assessment. The F.D.S. also acted as a Battle Exhaustion Centre but, due to the nature of the fighting, this type of case was uncommon as compared with campaigns of the 1939-1945 war. (See later.)

Situated near the hospital was a holding unit which carried reinforcements for the Korean force together with recovered battle casualties and sick soldiers again fit for duty. A considerable screening was effected and by close liaison with the M.O. and Adjutant of this unit many would-be psychiatric casualties were prevented, more often by recommending a hasty return to duty than advice to the contrary. Many of the cases referred were battle casualties who had recovered from superficial wounds and, although pronounced physically fit, persisted in complaining of impaired functions or persistent pain. A good number of these patients entertained their symptoms at a "near conscious" level. Providing, however, that this overlay did not amount to blatant malingering, it was considered advisable and advantageous to see such patients on one or two occasions for a period of psychotherapy. This was at times a rather tedious task, but such management usually paid a better dividend than a summary dismissal of the patient's symptoms (anxiety) as being imaginative or deceitful. It is quite certain that a soldier who can externalize his anxieties and fears to an ear which he recognizes as being both sympathetic and firm derives considerable benefit. His anxiety is predominantly the fear of personality disintegration in the face of danger rather than any specific fear of death, maiming or captivity by his enemy, and it was invariably on this theme that psychotherapy was gainfully rendered.

#### ENEMY ENVIRONMENT AND MORALE

The enemy, Chinese and North Koreans, inadequately supplied with artillery and air-striking power, compensated the deficit by attempting to overwhelm the opposition by gross numerical superiority. Their losses in large-scale offensives were reported to be enormous. They were most feared at night and, although initially silent in attack, during the battle they resorted to primitive methods of psychological warfare, sounding weird and oriental bugle calls.

This effect was at first eerie and nerve-racking, but, if calculated to lessen opposition morale, the result was short-lived and unimportant; certainly the matter was not stressed by patients suffering from acute psychiatric disturbances following combat either consciously or during abreactive treatment.

The climate in Korea is extreme. The cold winter appeared to be considerably less well tolerated than the warm, humid summer months. Living conditions were extremely harsh and weeks were spent in the open. Frostbite, a preventable condition, was not common during the winter 1950-1, but it is clear that the "cold injury," as the Americans have now labelled it, may constitute a serious problem. The U.S. authorities expressed grave concern about the high incidence in their troops, a significant number of which were considered to be self-inflicted by blatantly removing boots for a few hours or neglecting to take elementary precautions. It is probable that in future campaigns being undertaken in conditions of extreme cold the frostbite incidence will be the measure of individual, and therefore group, morale throughout the force. It is estimated that the extremely cold temperature was the soldier's greatest environmental hardship whilst in Korea.

Considering the many adverse factors, morale appeared to have maintained a surprisingly high standard which is reflected by the psychiatric breakdown, details of which appear analysed below. The dissatisfaction of the reservist, the impersonal, idealistic and remotely purposeful war, extremes of cold, heat and boredom, together with spurious peace offers, were factors not conducive to enthusiasm.

#### DISPOSAL OF ALL CASES INTERVIEWED

In the period of survey, 554 U.K. soldiers were referred for examination. Of these, 365 were recommended for a return to their unit; 112 were down-graded to medical category M2S3 and therefore became employable in base areas and were not a total loss; 8 men were given a category of M2S7 and 69 were evacuated to the United Kingdom. Of these 34 were psychotic, leaving only 35 soldiers who were sufficiently serious to require further hospital treatment for neurosis. It is noteworthy that during the year only ten officers were sent for interview. Three were diagnosed as Anxiety Reaction in obsessively perfectionistic personalities unrelated to battle circumstances, two had symptoms of headache with mild personality change following head injury. The other five developed excessive anxiety resulting from combat experience, and in all of these severe precipitating stress had occurred. Three officers were evacuated to England for further treatment and three down-graded to medical category M2S3 for three or six months.

TABLE I

R.T.U.	M2S3	M2S7	M2S0	
365 (65.8%)	112 (20.2%)	8 (1.5%)	69 (12.5%)	554

A diagnostic breakdown is given in Table II below.



TABLE II

Anxiety state	...	...	...	...	...	...	287
Hysteria	...	...	...	...	...	...	73
Maladjusted and psychopathic personality and dullards	...	...	...	...	...	...	42
Schizophrenia	...	...	...	...	...	...	22+(? 4)
Organic reactive psychosis	...	...	...	...	...	...	1
Manic depressive psychoses	...	...	...	...	...	...	7
N.A.D.	...	...	...	...	...	...	118

A note of explanation will be given on the cases seen.

*Anxiety Reactions.*—This was as usual the most common clinical entity encountered. The diagnostic rate is comparatively high, but many of these cases were mild and include a certain number of “dyspepsias.” This type of case was often amenable to reassurance and a special effort was made to follow them up when returned to their units, either by visiting them or by inquiries through their unit M.O. Often rather immature and dependent soldiers, this personal touch gave them a helpful measure of psychological support and security.

Acute “terror” or “panic” reactions are also included in this diagnostic group. These cases were at first surprisingly few and usually they had been adequately sedated on arrival at the base hospital. During the last few months of 1951 there was a considerable increase in cases of this nature, and almost certainly this was directly attributable to an increase in mortar and shell fire by the enemy. The diagnosis presents no difficulty—the patient is in a state of acute awareness, tremulous and uncommunicative, showing an excessive “startle reaction” to the slightest foreign auditory stimulus. The pupils are large and the *alæ nasi* often prominently dilated, as if the relatively dormant olfactory sense is being mobilized to augment the awareness of a subject in mortal danger. Sleep is easily induced with drugs though it may be interspersed with nightmares. Sodium amytal was used more than any other barbiturate, and in this connection it should be stressed that the initial dose should be large, say gr.  $7\frac{1}{2}$ –9, as smaller doses of this particular drug were noted to have an excitatory effect, especially in the subject who was excessively mute and tense. The further sedation varied in amount and no particular rule can be laid down, though in severe cases a minimum of two days’ deep narcosis is advisable. During the waking period the patient was reassured and orientated, and if it was apparent that he wanted to talk about his battle experiences this was allowed, though no attempt was made to encourage an abreaction.

It is well known that any physical or mental condition which effects a medical evacuation from a threatening or dangerous environment will be recognized by the patient, consciously or unconsciously, as a decided asset which, however, is conflicting with his sense of duty. It is precisely this conflict that must be solved if the soldier is to be returned to duty. Indecision and inability to face this reality was noted in some cases to cause a picture of clinical depression. With the decreased intensity of anxiety the patient very often became withdrawn, solitary and tearful. He declined food and, despite sedatives, remained

awake most of the night. Though the immediate psychopathology is obvious, the intensity of the repressed emotional experience is too great to expect a therapeutic acceptance. This depressive picture was more often observed in N.C.O.s., where the sense of guilt was roughly proportionate to the sense of expected responsibility. On the whole the prognosis for an immediate return to duty in such cases was poor.

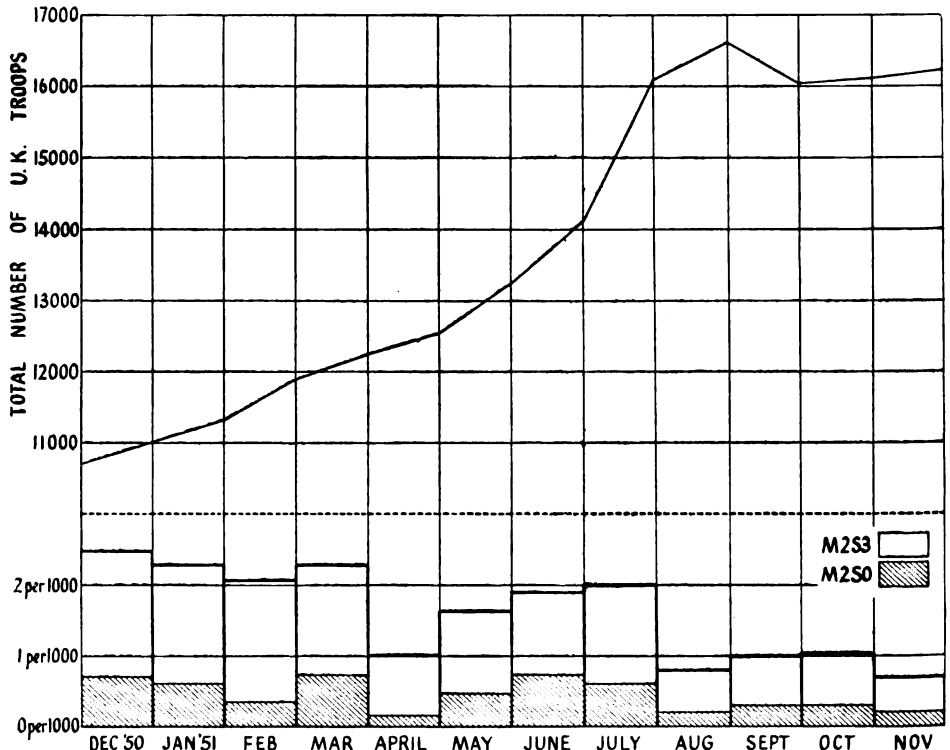


FIG. 1

- i. Graph showing psychiatric casualties per 1,000 soldiers each month. The upper level of each block indicates the total psychiatric loss. The shaded area represents those soldiers evacuated from the theatre (M2SO).
- ii. Above this appears a graph representing the total number of U.K. personnel in the theatre month by month.

*Hysteria.*—This group contained some who might well be classified as mild anxiety states, and also some post-concussional syndromes. Many were cases referred by medical or surgical specialists for assessment. Gross hysterical dissociation with conversion symptoms were not common, but again, with the increase in mortar and shell fire, they became more numerous. Hysterical stupor, blindness, and paraplegia or monoplegia were encountered in 20 patients.

All were amenable to treatment and showed a better total recovery rate than the acute panic and anxiety group.

*Psychopathic Personality and Mental Defect.*—In the Army one is always conscious of a tendency to label soldiers as Psychopathic Personalities, sometimes for administrative convenience, who do not truly present behaviour sufficient to justify the diagnosis. In this series 30 patients were assessed as being true Psychopathic Personalities (Type I and II), using as criteria a severe social maladjustment in both civilian and Army life with a history dating to childhood, together with an absence of a “normal” or average amount of insight. The majority of these cases presented because of pending disciplinary action and were unrelated to combat. Six patients with sexual aberrations (Psychopathic Personality, Type III) were interviewed, four of them again pending disciplinary action. Only six patients were considered to have an intellectual handicap justifying the diagnosis of Mental Defect.

*Schizophrenia.*—This diagnosis was made with certainty in 22 soldiers, who together with four suspected cases were all evacuated to England for further assessment. Only six of these could be related to battle experience, two of which became clinically evident in the front line. Simple and paranoid forms were the commonest types of schizophrenia encountered.

*Manic-Depressive Psychoses.*—Six soldiers were considered to have depressive symptoms with large endogenous components. They were mostly N.C.Os. in the older age group.

#### RELATIVE INCIDENCE OF PSYCHIATRIC CASUALTIES

In Fig. 1 are graphed the total number of troops in the theatre month by month as received from Field Records, B.C.F.K. On the lower part are graphed the psychiatric casualties in terms of total loss to the force through evacuation to England (medical category M2S0) and partial loss through down-grading to medical category M2S3 which necessitated restriction of the soldier to base areas only. These figures will be seen to be very small.

The high relative incidence for December to April can be attributed to the presence of reservist soldiers in the force, many of whom showed a lowered tolerance for hardship, to considerable enemy activity, including two large-scale battles, and to the stresses of the winter months. Peace talks began in July and the falling off of the casualty rate is presumably due to this, though there was still considerable patrol activity and from September there was a definite increase in mortar and shell fire.

During the year December, 1950, to November, 1951, there was considerable movement of troops in and out of the theatre and therefore the total monthly figures of troops reckoned as being in the theatre must be taken as being below the total number who could have been potential casualties. For example, the 28th Brigade was replaced in April by battalions from Hong Kong and the 29th Brigade was being replaced during the October-November period.

It is obvious from these figures that the loss of manpower due to psychiatric breakdown was negligible and presented no major problems to the administrative authorities. The writer has not at hand for comparison the exact monthly casualty and sick rate resultant from surgical and medical breakdown, but through observations and experience in the routine duties of Orderly Medical Officer admitting convoys of patients directly from the battle front, the proportion was roughly one psychiatric casualty for every twenty wounded or sick.

Some 275 cases from the Australian, Canadian, New Zealand, Indian and South African members of the Commonwealth Forces were interviewed. The personnel from these countries were almost entirely volunteers and together with some first-class material a considerable number of inadequate psychopaths and hysterics were included, whose tolerance for combat, hardship, and boredom was low. It was clear that their retention in the force would be detrimental to the morale of their particular group. Many had a previous (but undisclosed on enlistment) psychiatric history; a few members were even in receipt of pension for their "disability." The following is an analysis of all non-U.K. members of the Commonwealth Force who were interviewed:

R.T.U.	M2S3	M2S0	Total
138 (50%)	33 (12%)	104 (38%)	275

The combined number of non-U.K. troops in the Commonwealth units is not accurately available, but it would be fair to estimate it at about one-quarter to one-third of the total force. The percentage psychiatric breakdown was therefore considerably less in U.K. elements. This point is brought out not as a claim for superiority of any one member but to illustrate the very real importance and economy of psychiatric screening and personnel selection.

#### TREATMENT

Apart from continuous narcosis and abreactive therapy no other physical methods of treatment were used. The technique and management of these are well known and will not be given here. Abreactions were largely confined to patients presenting hysterical symptoms, and showed some quite dramatic "cures" which invariably enhanced the reputation of the operative psychiatrist. Reassurance, suggestion and an appeal to the soldier's sense of duty both to himself and, often more effective, to his unit are simple methods of psychotherapy which, despite an understandable scepticism because they are "simple" methods, give better results than might be expected. Psychotherapy at a "deeper level" was reserved for severe neurotics who, if recommended for evacuation to England, were confronted with a few weeks' delay. An alleviation of symptoms to some extent was usual, and any relevant psychopathology was forwarded with the patient's documents for the attention of the Military Psychiatrist at Netley.

#### SUMMARY

A brief report has been given on the incidence and type of psychiatric casualty encountered amongst British Commonwealth troops fighting in Korea.

The breakdown per 1,000 men is almost negligible, and it is felt that this was almost certainly due to the absence of intense enemy shell fire and aerial bombing. The R.T.U. rate for U.K. personnel was 65 per cent. and the number of relapses was insignificant. Anxiety reactions as usual were the most common clinical entity encountered and some success with a superficial form of psychotherapy can be claimed in a number of these cases.

The importance of psychiatric screening and personnel selection has been stressed and is exemplified by a comparison of U.K. troops with troops from other Commonwealth countries.

Frostbite has been mentioned and its incidence may in future campaigns be of importance in assessing the morale of a military force.

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## AN ANÆSTHETIST'S VISIT TO A U.S. ARMY HOSPITAL IN JAPAN

BY

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I VISITED the hospital, which was formerly a mission hospital and is now divided into a main block and an orthopædic annexe, on 9th and 10th December, 1951, and had a most cordial reception from the anæsthetic staff. We discussed anæsthetic arrangements in both armies and I had an opportunity of inspecting their equipment and watching them at work.

In the main hospital there is one central theatre block with five single-table operating theatres. There is one small room for anæsthetic equipment and stores. Inductions are carried out on the operating table in the theatre. Each theatre has one full-time anæsthetic nurse in charge and she has all the necessary equipment on the spot. Supervising the five sisters is a recognized anæsthesiologist of the American Board.

### EQUIPMENT

Each theatre has one Heidbrink or McKesson machine, standard Army models, using nitrous oxide, oxygen and ether only, and with double carbon dioxide absorption canisters. The former machine is good; the latter they considered poor because of the high resistance in the circuit.

The equipment and drugs are based on the simplest techniques and procedures, possibly because almost all the anæsthetics are administered by nurses. Each theatre has an anæsthetic trolley with adequate storage capacity for every likely requirement of the nurse during operation. Incorporated in the trolley is a suction pump for the use of the anæsthetist only. The nurse never leaves

the case during operation, and the anæsthesiologist is always available should there be any difficulty or trouble.

Theatre orderlies are available to change cylinders, etc., should this be required. Cylinders are all paired, large size, with pressure tubing delivery to the machines. Routine pulse, blood pressure and respiration charts are maintained in every case. The anæsthesiologist himself only does major pædiatric cases and the occasional very seriously ill patient. He also does all transtracheal injections, spinals, and major blocks, although the E.N.T. and thoracic surgeons do their own local procedures.

Cyclopropane and trichlorethylene are not used. Muscle relaxants are regarded as not yet being established and are therefore not authorized. Their supply through private sources is strongly deprecated.

Pentothal (thiopentone), which is used as the main anæsthetic drug supported by nitrous oxide and, when necessary, ether, is given slowly but in large total dosage. A  $2\frac{1}{2}$  per cent. solution is always used, given in the glucose drip from a 30 c.c. syringe via a three-way tap. Sufficient syringes are available to make up two to three days' supply at a time, and the charged syringes are stored in a Frigidaire. Induction is slow, to avoid any danger of apnœa. The drug is then administered intermittently throughout the operation, and doses of 2-2½ g. over one to three hours do not appear uncommon.

#### PREMEDICATION

The normal routine is : Nembutal, gr.  $1\frac{1}{2}$ , the previous evening ; nembutal, gr.  $1\frac{1}{2}$ , two hours before operation ; demerol (pethidine), 100 mg., one hour before operation ; atropine, gr. 1/150, 1 hour before operation.

Apart from the atropine, which appeared inadequate, the effect is excellent, and I have tried the sequence with satisfactory results.

"Transtracheal" cocainization worries the patients less after this premedication than when they have had either omnopon and scopolamine or morphine and atropine.

*Suction.*—Every case is carefully sucked dry post-operatively and, if necessary, tracheal toilet is carried out. I thought that premedication with atropine, gr. 1/150, as a routine was too small and persuaded the anæsthesiologist to try gr. 1/100. He seemed unduly scared as he regarded this as a possible toxic dose.

Young children up to six months of age are given no drying agent or premedication at all, atropine being considered too toxic.

*Neurological Cases.*—Premedication is by atropine, gr. 1/150, only, followed by transtracheal cocaine ; thiopentone induction, intubation and continuation with intermittent pentothal and nitrous oxide-oxygen only.

*Chest and Upper Abdomen.*—Standard premedication ; transtracheal cocaine, thiopentone induction, cuffed tube, thiopentone, nitrous oxide, oxygen and ether with aided respiration. Curare is not often used, nor controlled respiration.

*Lower Abdomen.*—Lower limbs, urogenital, rectal operations and cæsarians are all done under spinal analgesia using procaine up to 100 mg. in C.S.F., or pontocaine (amethocaine) up to 15 mg. in dextrose, or a mixture of both.

The anæsthesiologist is not really worried about post-operative morbidity following spinals, but we have noticed in the British Military Hospital that many patients who have spinals in Korea dread them and are extremely relieved when they inquire and find that we do not use them.

#### GENERAL

Caudal and brachial blocks are rarely given because of the time factor. Children are induced with vinethine (vinesthine). Demerol (pethidine) is rarely used as a supplementary agent during anæsthesia. Intubation seems to be done almost as a routine. I was told it was indicated for any operation lasting over one hour, but I saw it given in shorter cases without any special indication. The usual technique for intubation is :

- (a) Transtracheal injection of 2 c.c. of 4 per cent. cocaine while the patient takes a deep breath. He is then encouraged to cough and spit out any cocaine possible. The full effect comes on in five minutes and lasts up to twenty minutes.
- (b) After five to ten minutes, slow induction with  $2\frac{1}{2}$  per cent. thiopentone, 0.5 g. or more as required.
- (c) Intubation at leisure with insensitive cords and normally without "bucking." The only relative failure I saw was in a case of head injury with sticky, tenacious sputum.
- (d) Continuation by nitrous oxide, oxygen and intermittent thiopentone with or without ether.

*Comment.*—I have tried transtracheal injections in 18 cases. It works well for intubation, but it is uncomfortable and at times distressing (one case) and I do not think it justified as a routine.

#### FLUID REPLACEMENT

Every case of over fifteen minutes is given a minimum of 1 litre of 5 per cent. glucose by intravenous drip, started immediately prior to induction. A new set is used for each case and then discarded. One-fifth of saline and glucose is used if it is anticipated that blood will be required.

In principle, all fluids lost at operation are replaced at the time, with a tendency for the blood to be more than compensated.

Dextran is not used. I was told that this followed experiments in one U.S. Army hospital where dextran in conscious patients caused too high a proportion of reactions.

Syringes, needles, drip connections, etc., all have the one standard fitting. All are in good supply and of very high quality. They are sterilized by autoclaving.



## CONCLUSION

The U.S. system works smoothly and well. There is a delay of fifteen minutes or more between cases. The cough reflex usually returns during pharyngeal and tracheal toilet. Post-operatively the patients seem to do well.

All cases, apart from the thoracic and E.N.T., are transferred to a post-operative ward next to the theatre where there is a specially trained staff. The anæsthesiologist visits this ward from time to time during the day and is on close call at any time if required. Unconscious patients are nursed in the lateral or semi-prone position.

My feeling is that the system is simple and safe, and the results good. Possibly the results are not quite so good as ours where we have doctors administering the anæsthetics and are therefore allowed a wider and more appropriate range of agents.

I do not like their extensive use of spinals.

## MILITARY OPHTHALMOLOGY IN SINGAPORE AND MALAYA

BY

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THREE years of ophthalmic practice for the three Services and Foreign Office staff in Singapore and Malaya from 1949 to 1952 has led to some observations which are recorded in this paper.

### INJURY TO THE EYE

Seventy-seven cases of injury to the eye were admitted to the eye wards of the B.M.H., Singapore, which was approximately 16 per cent. of all ophthalmic admissions. The causes of these injuries were numerous, and no particular cause could be held responsible for any large group of cases which could be eliminated by more care and protective means.

The causes of injury to an eye may be summed up as follows :

	Cases	Approximate Percentage
1. Injury by instruments ( <i>e.g.</i> , screwdriver, tin opener, wood chopper, knife, hammer and chisel) ... ..	16	21
2. Miscellaneous causes ( <i>e.g.</i> , blows on eye by fist, knocking into objects, struck by moving objects) ... ..	16	21
3. Sport ( <i>e.g.</i> , blow on face by football, snapping of metal bow in archery, struck by a finger whilst swimming, kick in eye) ... ..	13	17

	Cases	Approximate Percentage
4. Accidents with firearms ( <i>e.g.</i> , explosion of thunderflash, blank cartridge, premature explosion of hand grenade)	11	14
5. Chemical burns ( <i>e.g.</i> , by brake fluid oil, unpacking crates of ammonia fortis) ... ..	7	9
6. Car accidents ... ..	7	9
7. By jungle growth ( <i>e.g.</i> , lallang) ... ..	6	8
8. Enemy action ... ..	1	1

The injuries produced were :

1. Corneal wounds ... ..	15	19
2. Hyphæma ... ..	11	14
3. Prolapse of iris ... ..	9	12
4. Commotio retinæ ... ..	7	9
5. Vitreous hæmorrhage ... ..	6	7.5
6. Tear of conjunctiva ... ..	5	7
7. Laceration of eyelid ... ..	5	7
8. Corneal F.Bs. ... ..	5	7
9. Intra-ocular F.Bs. ... ..	5	7
10. Laceration of sclera ... ..	4	5
11. Traumatic cataract ... ..	3	4
12. Detachment of retina ... ..	2	2.5

Fifteen cases (*i.e.*, 19 per cent.) were penetrating wounds of the eye, for which removal of an eye was necessary in five cases.

There were two types of injury which are of special interest. First, two severe injuries were caused by the snapping of the metal type of bow used in the practice of archery. If such a bow snaps when fully bent in front of the eye, the full impact of a broken end of the bow is received by the eye. In one case it caused rupture of the eye which required removal, and in another case it caused a massive hyphæma and vitreous hæmorrhage, the visual acuity only recovering to 6/18. Although a calculated risk must be taken in all sport, it is considered that two such severe injuries occurring in the comparatively very few who practise archery shows the danger of using a metal bow. Secondly, two cases of burns of the eye occurred in men engaged, on separate occasions, in the unpacking of crates containing bottles of ammonia fortis. In both cases a cork unexpectedly flew off a bottle and allowed escape of vapour which caused severe denuding of the corneal epithelium. Both cases fully recovered.

#### EFFECTS OF ULTRA-VIOLET LIGHT AND USE OF TINTED GLASSES

Excessive ultra-violet light will cause lacrimation, photophobia, swelling of the conjunctiva and corneal involvement. At no time is it considered that the intensity of illumination and ultra-violet light in Singapore and Malaya is sufficiently strong to cause any serious pathological changes in the eye. The constant humidity, heat and glare will, however, produce in many people a condition of bloodshot and irritable eyes as a reaction of the conjunctiva to the climatic conditions, just as the skin will react to these conditions. It is better

to explain the cause of the symptoms to the patient, who often gains great relief by discontinuing the use of various proprietary lotions and eye drops which have, in addition, produced a chemical conjunctivitis. Castor oil drops inserted into the conjunctival sac are often found to be helpful. A mechanical conjunctivitis is nearly always produced after two or three hours in an air-conditioned room or where there are strong fans in use. This is due to excessive drying of the conjunctiva, which is then more susceptible to the trauma caused by minute particles of dust and tobacco smoke suspended in the air.

Taken by and large it was advisable to discourage the use of tinted glasses. Obviously, the soldier is at a disadvantage to be encumbered with the wearing of tinted glasses and consequent loss of sharp vision when on active operations in Malaya. Exceptions were in cases of high myopia with large pupils, persons of very fair complexion, and in drivers who were especially apt to complain of glare. Sunglasses were ordered in such cases with the advice that they should only be worn when the intensity of light produced discomfort. Cases with even a small iridectomy were found to be most intolerant to light and required boarding home to the United Kingdom.

Rayban tinted lenses are advised for use in the tropics. They are 100 per cent. effective in cutting out ultra-violet light compared with 96 per cent. effectiveness of Crookes B2 lenses. Further, Rayban lenses transmit colours and the world does not appear dull and depressing as is the case with many other makes of dark glasses. Removable shields are not recommended as they often produce distortion.

For some there is a glamour in wearing tinted spectacles, as is well illustrated by an article in a local paper headed "Glamour in Sunglasses. . . . Frames tend to be more streamlined than chunky this season. Shining black is striking. Latest sunglasses have extra lenses set into the side pieces to widen vision and protect the eyes from sidelights. Others have slots in these side pieces through which a scarf can be threaded. Smart idea in London and Paris is to have the frames of your glasses made to match your dress. . . ."

#### SPECTACLES AND CONTACT LENSES

The much maligned Mark III spectacles proved of great value in Malaya. Indeed, it was remarkable how many people who had not bothered to equip themselves with spectacles other than the civilian type asked for the Mark III pattern when involved in active operations in the jungle. The frames have the following advantages: (1) They are light; (2) do not easily come off; (3) are cooler to wear; and (4) are less of an encumbrance on firing a rifle than the civilian type.

It should be considered to what extent contact lenses would help a soldier on active operations. If the making of these lenses could be improved so that they can stay in place for long periods (*i.e.*, twenty-four hours), they would be of great benefit to the soldier, who would be relieved of the frustration of wearing glasses in a hot and humid climate, and who would gain clearer visual acuity.

A patient from the Foreign Office department who had worn contact glasses

for three years in London without difficulty found she was unable to tolerate them on arriving in Singapore. There was no obvious explanation for this, but perhaps that the change in climate slightly altered the pressure of the eye, giving a change in the shape of the eyeball. It is worth while to record this case as it shows it would be necessary to have a contact lens centre in Singapore to deal with such cases if the wearing of contact lenses should, in a few years time, become general for forward troops. Further, it would be necessary to ascertain whether a change in the pressure and shape of the eyeball occurs in any considerable percentage of persons going to the different climate of the Far East, as this would affect the fitting of contact lenses made in the United Kingdom.

#### ARTIFICIAL EYES

Although a soldier in the British Army who has had an eye removed is graded non-tropical, it must be remembered that patients may be met in the tropics who do wear an artificial eye—*e.g.*, families, Malay personnel, and civilian staff. There are no facilities in Singapore for the making of artificial eyes, but it was possible to produce them from stock eyes which were ground to fit the orbit by the dental mechanic. Even if a good match could not be obtained it prevented contracture of the orbit. There is no doubt that plastic eyes are infinitely preferable to glass eyes. The latter erode much quicker in the tropics and are soon unserviceable.

#### CORRECTION OF STRABISMUS

The number of children from the three Services having a squint was surprisingly high in so relatively small a child population. Thirty-three cases, ranging in age from three and a half years to eight years, were operated on for correction of strabismus.

Orthoptic treatment was not available and the routine treatment for these patients was correction of refractive error, occlusion for four to six weeks if there was not a long history, and then operation. The covering of a lens and side-piece with adhesive tape was the most practical way of occluding an eye. Directly covering the eye is more effective, but this is difficult and uncomfortable in the warm and humid atmosphere of Singapore.

It was considered that very early operation is the correct course to take in a place such as Singapore, where no orthoptic treatment is available. Indeed, many of the cases had lingered on for years, resulting in loss of binocular vision, because of the attempt to treat by a course of orthoptics. Then, owing to an unexpected posting, the treatment was postponed for three or four months, only to start again on another course of orthoptics in another strange place. All this is most disheartening for the patient, and for the parents who see little, if any, improvement and may well discontinue taking the child to hospital. Further, in Singapore and Malaya, where the patients are scattered over a vast area, it would be impossible to give a prolonged course of orthoptics unless the patient was admitted to hospital. This is not desirable for an otherwise healthy

child, besides having the disadvantage of occupying a bed for long periods. A synoptophore would, however, be useful for diagnostic purposes, and for determining the amount of fusion and binocular vision.

There were numerous cases of soldiers with an amblyopic and squinting eye. Operative treatment was only carried out in three of these cases. It was considered that the hospitalization and absence from duty is not warranted for a purely cosmetic operation unless the patient especially asks for the eye to be straightened, and it is likely that the psychological effect of this would increase his efficiency and help him in both his Army and civilian careers.

#### USE OF CORTISONE, PENICILLIN, AND ATROPINE

Cortisone was available at the end of this period and was used in four cases. In a case of acute iritis it was given by subconjunctival injection. (Two injections of 0.4 ml. of a 25 mg. per ml. cortisone acetate suspension at forty-eight-hour interval.) There was no marked immediate improvement, but the eye completely recovered. This was in contrast to the other eye of this patient, which had had a similar attack five years previously and ended in secondary glaucoma requiring operative treatment and reduction of visual acuity to 6/24.

A case of very severe corrosive burning of the cornea and conjunctiva, which had remained red and irritable for a month, showed very marked and immediate improvement within forty-eight hours of one subconjunctival injection of cortisone, and the eye was practically white within a week.

Two cases of penetrating wound of the eye were treated with gutt. cortisone, a drop two hourly, and both eyes were healed and almost white within six days. Cortisone was also applied to the uninjured eye in similar dosage as a prophylactic against sympathetic ophthalmia.

Penicillin in the form of eyedrops (10,000 units of crystalline penicillin to 1 ml. water) was frequently used for extra-ocular infections. One disadvantage in the use of this antibiotic in the tropics is that the solution must be kept cold in a refrigerator and, therefore, a patient has the discomfort of icy cold drops going on to the eye at hourly intervals. To overcome this, it was considered best to have small quantities of fresh penicillin drops prepared each day and for the solution not to be placed in a refrigerator.

One per cent. atropine solution used as a mydriatic in Asian personnel was found to be ineffective in producing full dilatation of the pupil, even when the atropine sulphate was known to be up to strength. Owing to the extra pigment in the iris in these patients, and the stronger sphincter muscle (due to constant contraction of the pupil because of the glare), it was found that at least a 2 per cent. solution of atropine was required to produce full dilatation of the pupil.

# A NEW SALMONELLA TYPE: SALMONELLA SEREMBAN

BY

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and

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A CULTURE of a new *Salmonella* type of organism was received during August, 1952 ; it had been isolated from several patients suffering from food poisoning at Seremban, Malaya (Robinson, T. M., 1952, personal communication).

On desoxycholate-citrate agar this organism produced non-lactose fermenting colonies typical of the *Salmonella* group. It is a Gram-negative, motile rod with the following biochemical reactions : fermentation of glucose, maltose, mannitol, dulcitol, rhamnose, trehalose and inositol with the production of acid and gas in twenty-four hours ; no action on lactose, saccharose, salicin, adonitol, sorbitol and xylose. The citrate utilization test was positive ;  $H_2S$  was produced but indole was not formed ; gelatin was not liquefied ; and urease was not produced.

When examined serologically the organism was agglutinated to titre by *Salmonella typhi* "O" serum and reciprocal-absorption tests using this serum, *Salmonella paratyphi A* "O" serum, *Salmonella paratyphi B* "O" serum,

TABLE I

Serum "O" of unknown <i>Salmonella</i>	Suspensions				
	Unknown <i>Salmonella</i> "O"	<i>S. paratyphi A</i> "O" (HA6) I, II, XII <sub>1</sub> , XII <sub>2</sub>	<i>S. paratyphi B</i> "O" (HB3) IV, V, XII <sub>1</sub> , XII <sub>2</sub>	<i>S. typhi</i> "O" (901) IX, XII <sub>1</sub> , XII <sub>2</sub> , XII <sub>3</sub>	<i>S. reading</i> "O" IV, XII <sub>1</sub> , XII <sub>2</sub>
Unabsorbed	960	320	320	800	280
Absorbed with <i>S.</i> <i>paratyphi A</i> "O" (HA6) suspension	280	Less than 40			
Absorbed with <i>S.</i> <i>paratyphi B</i> "O" (HB3) suspension	40		60		
Absorbed with <i>S.</i> <i>typhi</i> "O" (901) suspension	Less than 40			60	
Absorbed with <i>S.</i> <i>reading</i> "O" sus- pension	60				Less than 40

TABLE II

Suspension Unknown <i>Salmonella</i> "O"	Suspensions				
	Unknown <i>Salmonella</i> "O"	<i>S. paratyphi A</i> "O" (HA6) I, II, XII <sub>1</sub> , XII <sub>3</sub>	<i>S. paratyphi B</i> "O" (HB3) IV, V, XII <sub>1</sub> , XII <sub>2</sub>	<i>S. typhi</i> "O" (901) IX, XII <sub>1</sub> , XII <sub>2</sub> , XII <sub>3</sub>	<i>S. reading</i> "O" IV, XII <sub>1</sub> , XII <sub>2</sub>
Absorbing <i>S. paratyphi A</i> "O" (HA6) serum	(140) Less than 40	(1280) 960			
Absorbing <i>S. paratyphi B</i> "O" (HB3) serum	(60) Less than 40		(1280) 960		
Absorbing <i>S. typhi</i> "O" (901/0) serum	(240) Less than 40			(3500) 280	
Absorbing <i>S. reading</i> "O" serum	(480) Less than 40				(640) 60

Note—Figures in brackets are the sera titres against each suspension before absorption.

*Salmonella reading* "O" serum, and one made from the new strain proved that the "O" complex was IX, XII<sub>1</sub>, XII<sub>2</sub>, and XII<sub>3</sub>.

The organism was diphasic and in its first phase was agglutinated to titre with *Salmonella typhimurium* "H" (i) serum. In its second phase the organism was agglutinated to titre with *Salmonella mission* var. *isangi* "H" (1, 3, 5) serum. Reciprocal absorption tests showed that the "H" antigens of the new organism were i=1, 3, 5.

The presence of the "O" (IX, XII<sub>2</sub> and XII<sub>3</sub>) and "H" (i, 1, 3, 5) antigens was confirmed by single factor sera.

The serology is summarized in Tables I and II.

#### SUMMARY

A new *Salmonella* type is described, for which the name *Salmonella seremban* is proposed; it has the antigenic formula IX, XII<sub>1</sub>, XII<sub>2</sub>, XII<sub>3</sub>; i=1, 3, 5. It was the apparent cause of a number of human cases of food poisoning.

# TREATMENT OF GONORRHOEA WITH TWO GRAMMES OF TERRAMYCIN IN UNEQUAL DIVIDED DOSES OVER TWENTY-FOUR HOURS

BY

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THIS is the fourth of a series of reports on the treatment of acute gonorrhœa with 2 grammes of terramycin. The first (1) referred to the results obtained by a single mass dose of 2 g., and the same amount in two doses each of 1 g. given six hours apart; the second to those of 2 g. given in eight six-hourly doses over 48 hours (2); and the third to 2 g. given in four doses of 500 mg. over 24 hours (3). The present paper concerns 45 cases of uncomplicated gonorrhœa treated with an initial dose of 1 g. followed by four doses of 250 mg. given on four occasions during the ensuing 24 hours, all doses being administered orally.

## THE CASES

Forty-four of the patients were male and one was female, 32 were single and 13 were married. The average age was 30.4 years (extremes 20-55). Twenty persons had no previous experience of venereal disorders, but 25 patients had had no less than 41 previous venereal episodes (32 of gonorrhœa, 6 of syphilis and 3 of non-specific urethritis). Six of the males were negroes from West Africa or the West Indies, of whom two denied having had previous venereal disease, while four had five attacks of gonorrhœa and one of syphilis between them.

Of the 44 males, 34 had noted a discharge 1-3 days before seeking advice, 7 for 4-7 days, and 3 for two weeks. Some dysuria was present in the majority. The Wassermann and Kahn reactions were both negative in 40 patients, 4 showed initially a negative Wassermann but a hypersensitive Kahn, and one gave strongly positive readings to both tests. The gonococcal complement fixation test was performed in 35 cases, being negative in 31 and positive only in 4.

## THE RESULTS

Eight patients did not attend again after treatment. Of the 37 followed, 35 were observed for 4-7 days, 26 for 8-14 days, 22 for 15-28 days and 14 for longer than this time. The status of 31 patients (83.8 per cent.) was entirely satisfactory at the times seen. There was only one definite failure in which gonococci recurred in the smear at 16 days. This patient denied other exposure and was treated with penicillin. There were, however, five patients who subsequently developed non-specific discharges in which gonococci were not found. These were considered to be infections with non-specific urethritis unconnected



with the gonorrhœa. Two of these, noted at 4 and 8 days respectively from treatment, were given a further 2 g. of terramycin as before and remained subsequently well following 35 and 45 days respectively of observation. It is possible that these two cases were retreated unnecessarily. One patient developed a non-specific urethritis at 26 days and was retreated with sulphadiazine, and another, who was apparently well at 57 days, attended with a non-specific discharge at 96 days which may well have arisen from a second exposure. One other patient showing a non-specific discharge at 26 days had bilateral swollen ankles and a sedimentation rate of 10 mm. in one hour. He was considered to be suffering from Reiter's syndrome and was treated with penicillin.

As the incubation period of non-specific urethritis is longer than that of gonorrhœa, the presence of a non-specific discharge following the apparent cure of gonorrhœa does not necessarily imply that further sexual contact has taken place as the two diseases may be acquired simultaneously. It is interesting to note that terramycin, which is curative in established non-specific urethritis, failed as a prophylactic in these cases.

The treatment was generally free from side-effects, although two patients developed the ano-rectal syndrome of burning and pruritus which has already been described (4).

The results are summarized in the table.

TABLE I.—STATUS AT LAST EXAMINATION OR AT FAILURE

<i>Days</i>	<i>Followed</i>	<i>Total Followed</i>	<i>Failures G.C. plus</i>	<i>Non-specific Urethritis</i>
0 ...	8	45	—	—
1—3 ...	2	37	—	—
4—7 ...	9	35	—	1
8—14 ...	4	26	—	1
15—21 ...	4	22	1	—
22—28 ...	4	18	—	2
29—35 ...	1	14	—	—
36—42 ...	2	13	—	—
64—70 ...	1	11	—	—
85—91 ...	1	10	—	—
92—98 ...	1	9	—	1
99—105 ...	5	8	—	—
106—112 ...	1	3	—	—
120—126 ...	1	2	—	—
140—147 ...	1	1	—	—
	45		1 (2.7%)	5 (13.5%)

#### SUMMARY

Of 45 patients with uncomplicated gonorrhœa treated with 2 g. of terramycin given orally in an initial dose of 1 g. plus four doses each of 250 mg. during the ensuing 24 hours, and followed for varying periods up to 146 days, there was only one gonococcus-positive failure requiring retreatment. In addition,

there were five cases (13.5 per cent.) showing non-gonococcal discharges, one of which had Reiter's syndrome, which were considered to be infections of non-specific urethritis.

## REFERENCES

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- (3) WILLCOX, R. R. (1953). *Med. J. Aust.*, i, 260-1.
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The terramycin used in this study was kindly provided by Charles Pfizer and Co. Inc. of Brooklyn, New York.

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## FURTHER WANDERINGS OF THE YACHT "MARCUS AURELIUS"

BY

Colonel R. V. FRANKLIN

It took a bit of persuading my boss "The Admiral" that a good long leave was vital to my well-being, especially as I had spent most of the early summer divided between an exciting "Exercise" in B.A.O.R. and an equally good one on Salisbury Plain. However, as always, virtue was rewarded, and on Saturday, 9th August, thinking in terms of blue water and sunshine, my son Barn, recently returned from his C.C.F. camp, and myself drove from Catterick to Cairnryan in Wigtownshire and boarded my 15-ton sloop *Marcus Aurelius* with the prospect of a whole twenty-eight days aboard ahead of us.

Our plans were that next day Gin, my wife, Took's, my thirteen-year-old daughter, Jack, a bachelor doctor and Gin's brother, and my good friend Jonath Jones of the R.A.S.C. should join us aboard and then we should then make a fair course for Ireland. To accommodate the crew comfortably (*sic*) aboard, the children shared the fo'c'sle, Barn sleeping on a mattress on the sail locker. Jonath and Jack shared the owner's cabin aft with its two comfortable bunks, and the skipper and his wife occupied the saloon settees. A seventh member of the crew, Coco, the dachshund, took up little room in the bottom of the clothes locker. It rained and it blew from the wrong direction, so departure was inadvisable. We shopped at Stranraer and walked over the hills, where I discovered the Garrison Mess of which I was made an honorary member and was able to quench the thirsts of the crew. We also discovered a garage at 1s. 6d. a night for our cars quite near the steamer pier. The steamer leaves twice daily, takes two hours to get to Larne, and the cost is about 13s. with an Army concession voucher.



good shower from buckets transferred from *Marcus*. Indeed, if we at any time found that the *Stradella*, as she is called, had sunk or was sold or even that another yacht had tied up to her, we would be very annoyed. This time we sailed twenty-six miles and took six hours to do it.

It was discovered on the passage up that the lavatory would not function, so I dismantled it as soon as we tied up—a most unsavoury job, but well rewarded by the discovery of a large shackle-pin stuck in the valves, obviously carelessly dropped in by someone fearful to say so. Orders were issued to keep the lid down always except at times of operation, and the penalty was that the last user would do any further dismantling, should it not function again. This was the one order obeyed assiduously.

Jonath departed next day so the accommodation was rearranged. Gin and Took took the aft cabin, Jack with me in the saloon and Barn remained in the fo'c'sle. Though the aft cabin is more comfortable, I prefer my saloon bunk as the ancient portable battery wireless (purchased in 1945 from a disbanding Field Ambulance) is "ever ready" to give me the news and weather forecasts.

Tarbert is a delightful, pretty and most sheltered natural harbour. Having a large herring-fishing fleet, it is a grand sight to see the women in their leather aprons gutting the fish on the quayside with lightning speed whilst the gulls fight and scream around. Eggs are obtainable, but oh ! at what a price ; Gin, when told she could have as many as she liked, was delighted, but her cautious Scots forebears caused her to price them and she was not quite so pleased to find they cost 8s. to 9s. a doz. We spent a grand day roaming the hills and visiting the yacht yard.

Our next port we decided would be Loch Gair, a perfectly unspoilt and safe anchorage three miles above the Otter spit and approximately fourteen miles from the head of Loch Fyne and capital of Argyllshire, Inverary. The sea was calm, the wind light and behind us, and the tide was with us, so we departed next day, 15th August, at 1430 hrs. A large and lovely black yacht under power against wind and tide coming the opposite way altered course to look at us, and when within hailing distance I recognized *Sea Bear*, whose owner possesses estates and, what was more important to me, mooring in Loch Gair. Being ever an opportunist, I yelled over my megaphone and obtained his permission to use his mooring during my stay in the Loch. Everyone in this small place seems to be called MacVicar. We thought it quite a joke on asking where we might get eggs to be told to go to a certain Mrs. MacVicar at a farm. She put us on to another Mrs. MacVicar for milk. For bread and vegetables we went to two other places and each of them bore the name MacVicar. Incidentally, eggs were reasonable.

We were up early next morning to catch the tide up Loch Fyne and set our nose for Inverary. Once out of Loch Gair, however, we found the wind had changed in the night and was now in our teeth. What to do ? Obviously Inverary was out of the question unless with hours of engine, which none of us liked. Gin wanted provisions, so to ponder the question we returned to *Sea Bear's* moorings and had breakfast. At the reasonable hour of 0830 we sailed

down Loch Fyne for Ardrishaig, a nice little town at the entrance of the Crinan Canal and waterway (inland) to the west coast. As it was only a short distance we tied up to the north pier by 1130 hrs., which gave the family time to shop. The cost of entering the canal basin is 3s. 6d. and is well worth it when in a storm, but we did not wish to stay, so at 1315 hrs. we cast off and had a spanking sail with the wind on our beam back to Tarbert, where we again tied up to *Stradella* and rebathed.

Our next move was up the West Kyle off Bute Island. The wind being east and strong, a proper sailor would have done a long beat from Tarbert, but I think it important not to allow the crew to get fed up, so took the easy way and proceeded under engine to the entrance of the Kyle, where we hoisted our canvas and had a perfect sail in smooth waters past Tighnabruaich up to the narrows, and when we saw two yachts at anchor in calm water close inshore at Fearnoch Bay we also dropped a hook, made tea and also brought Coco for her walk ashore. It is very deep here and the boat seemed almost ashore before bottom at ten fathoms (60 feet) was found. Being snug and sheltered, I would have liked to stay the night, but if the wind had changed, with five times the depth of the chain out, *Marcus* would have been in danger of going on the rocks, so at 1830 hrs. we weighed anchor and with a strong wind, which was increasing, we had a marvellous sail past Colintrave to pick up a mooring at Port Bannatyne in Kames Bay, about six miles from Rothesay, about 2000 hrs.

It was very wet and windy next day so the family decided to go to Glasgow by the steamer from Rothesay to do some pre-school term shopping, from which they returned quite happy after an absence of eight hours.

The 19th August found us at 0700 hrs. all set for a course to Troon. It was a nice clear day, wind and tide favourable, so we passed between Great Cumbrae and Largs. About 1600 hrs., when approaching Troon, Jack grumbled that the industrial dockyard of Troon would compare very unfavourably with the peace and calm of Lamlash, so we put the boat about on the other tack and at 1930 hrs. again anchored in our former position in Lamlash. There were several yachts at anchor, amongst which I recognized *Sea Bear* and was able to thank her owner, Major Douglas-Dixon, who was also enjoying a family cruise, for the use of his mooring at Loch Gair.

The ship's company, less Tooks and myself, next day walked to Brodick Bay and talked of climbing Goat Fell. I fiddled aboard and Tooks baked a cake. Perhaps it would be of interest here to mention some of our domestic arrangements. We have a really nice galley with a calor gas stove complete with oven. Water by tap is to hand, but we always wash up in sea water and keep a special kettle for heating it up. A drop of "Quix" in the sea water makes all the difference and helps considerably in getting grease off. There is a nice little pull-plug washing basin. All crockery is at hand and packed in fiddles so they do not rush madly around when the boat heaves. The whole of the galley is lined with Formica and a wipe with a damp cloth ensures it is left clean. Two golden rules to be observed here : (1) The gas is always turned off at the cylinder after every use (I have heard of many boats being blown to smithereens) ;

and (2) whoever prepares the meal must not wash up. In fact, we take it in turns daily to wash up and the name is logged, so there is no argument.

As time for Jack was getting short and the wind favourable, our plan next day was to make back to Loch Ryan. We desired the ebb out of the Clyde and then as much flood as possible, as this sets south at two to three knots and is a big help. At 0700 hrs. in clear weather we had a quiet sail past Ailsa Craig, which today was quite clear. Many steamers passed us entering and leaving the Clyde ; they always seem to leave the Craig on the seaward side. We passed fishing drifters quite close and had a cheery word with their crews.

I had made up my mind, as I still had two good weeks' leave left, that I would sail over to Ireland. On announcing my intention there was a great discussion aboard as to whether Gin and Took would accompany me. Of Barn there was never any doubt ; as long as good sailing was available, there he would be. Took was not keen to face the Irish Sea, and though Gin was most anxious to come, her maternal instinct decided her to take her young daughter to the safety of home. This decided, we held on our course and tied up to our moorings at Cairnryan at 1900 hrs., having sailed thirty-six miles in twelve hours.

I was glad to see Jonath again aboard at 0700 hrs. on 21st August as Barn and I felt lonely after the departure of the family. The wind and tide were most unsuitable ; so again, unlike true sailors, but wisely, we took a tow to well out of the Loch and in fine weather and light breeze set our sails and set our course for Belfast Lough. The wind fell very light, so we had to use our engine, and the crossing of the Irish Sea turned out to be a very tame affair for us. By 1400 hrs. we had Blackhead abeam, and half an hour later we were off Whitehead. A small calamity occurred about here, for on shutting off the engine when a breeze came up, the cut-out went up in smoke. Jonath, ever resourceful, saved the situation by disconnecting the battery lead. At 1630 hrs. we picked up a mooring at East Bay at Bangor. Ashore we called at the Royal Ulster Yacht Club, where we were most hospitably received and enjoyed not only an excellent dinner but scalding hot baths.

On Sunday, 24th August, having returned from church, we discussed our next move, and, the wind having gone south-west, it was unsuitable to proceed to Dublin as we wished, particularly with a light crew, and the "funk holes" between Belfast and Dublin, where a small vessel may run in safety if necessary, are non-existent. The yacht anchorages in Belfast Lough are rather exposed and it is unwise to leave them unattended. We thought perhaps at Larne we might find a snug billet, so after lunch we sailed the few miles up there at a gentle pace. We were lucky to pick up another yacht entering Larne Lough and called across to them asking if they were locals. They were, and the skipper gave me every assistance in finding an anchorage and a boatman to look after *Marcus* and even an electrician to renew the burnt cut-out. This yacht, *Windhover*, was owned by John Corrie and had just completed a cruise in Scottish waters.

Jonath departed next day and I visited Bob Dick, an ancient and most charmingly dour boatman who lives on Island Magee. He refused point blank

to have any responsibility for *Marcus* whilst on her anchor, but suggested I should bring her into a small harbour near by his house where she would take the ground but would be safe from all winds and where he would undertake the responsibility of looking after her. This decided me, particularly as the bottom was soft mud, and on the evening tide in we went, tied up to the quayside, adjusted our warps and had a most comfortable night.

Having seen that *Marcus* was safe and in good hands and fixed with the electrician to do the jobs in our absence, Barn and I departed at 0745 hrs. next morning by bus for Whitehead and then by train for Belfast. We reached this city in plenty of time to catch the "Enterprise" at 1030 hrs. to Dublin. On arrival our immediate object was a steak at Jammet's, to which we did full justice. After which, with an air of proprietorship, I showed Barn round Trinity College, where I had already left our sea bag in the care of a cheerful and courteous porter.

We then took a bus to Sandycove, where I was reared, and spent the next two days visiting relations and friends. The shopkeepers seem to go on for ever. I was greeted by a large smile of welcome from the owner of one grocery establishment which I used to visit pre-1914 war tagging on to my grandmother's skirts. As before, I was offered whole orange "on the house." One minor excursion I always make when in Dublin and from which I always get a tremendous kick is to visit my professional colleagues in their consulting rooms. No matter how busy they are they seem delighted to see you even just for a moment. Seymour Heatley, whom I last saw as O.C. Surgical Division of a hospital in Belgium, looked grand and was sporting a R.A.M.C. tie. Togo Graham found time to brush a patient aside and bring me to his private den for a cup of tea. To mention them all would be fatiguing, but certainly they all welcomed my calling.

I was lucky in having a young and beautiful cousin in Dublin who constituted herself my guide and driver and who would not permit us to bus or walk anywhere. I got a bit of a kick out of this for there was I, rather dirty, middle-aged, in old boat clothes being carted around by a ravishing young thing who didn't mind or care in the least. Amongst other places, she drove us out to see my old school, Clongowes Wood College, Kildare, where I had not been since 1917. Barn was, or said he was, suitably impressed.

Our visit had come to an end all too soon, so we once again boarded the "Enterprise" at Amiens Street Station; at least it was a relief train we went on as we had not booked, so we were late arriving in Belfast. This did not in any way deter Tommy and Kanky Davidson, who gave us the most enormous lunch in their lovely home. I used to have an uncle, a vet., in Belfast called Ewing Johnston, and I was very pleased when his daughter Emily called for us and brought us back to her house at Shaws Bridge for tea, and then speeded us on our way with the remains of the home-made cake and a tin of butter.

On arrival back on *Marcus* I found all well and that the electrician, Mr. A. Logan, had done a great job. Not only had he fitted a new cut-out but also a junction box, a blow fuse and a master switch, all at a reasonable price. As

my cousin Emily says, the Ulsterman is loyal to the Crown and the half-crown, but he certainly gives you value for money.

Saturday, 30th August, and the last day of our cruise. Up at 0600 hrs. at high water so as to catch the tide out of the little harbour, having taken my leave of Bob Dick the night before. Jonath, the ever reliable, hopped off the steamer and hopped on *Marcus* for the sail back to Loch Ryan, which we started at 1000 hrs. The wind was strong from the south-west and visibility very poor as we could only see about a mile ahead. Once again we had to trust to our navigation and the compass and both proved reliable, for after six hours of sailing, mostly in fog, we once again tied up to our own moorings at Cairnryan.

This is the end of my tale. It was the greatest fun and by taking reasonable precautions we ran no undue risks, and we were blessed by having no rain, nice breezes and calm seas throughout our cruise.

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## DOWN AMONG THE Z MEN

BY

Colonel M. H. P. SAYERS, O.B.E.

PREPARATIONS for the reception and training of field transfusion units in Wiltshire were begun in January, some five months before the first reservists were due to arrive. A hutted camp was made ready for them and steps taken to see that everything was done, within the limits of Army schedules, to ensure their comfort. Special attention was given to the details of the reception arrangements so that the Z men had the feeling at the outset that they were really welcome. A personal letter was written to every officer and man giving him an insight as to what he could expect and indicating the attractions of fourteen days' soldiering on Salisbury Plain.

The response on the part of the reservists to this human approach was apparent on their arrival, when it was evident that all, from ballet dancer to bricklayer, were resolved to make the best of the occasion and co-operate to the full in making the training a success. Reception was a cheery affair and nearly everyone appeared in good spirits. As truck-loads of reservists arrived from the station and were shown to their quarters, the camp came to life and the men were given a hot meal before being fitted out at the Quartermaster's Stores.

They emerged in all their glory to repair to the canteen to renew old friendships and discuss, over pipe and ale, days and campaigns already beginning to fade. It was a heartening sight to see older men in uniform again, with breasts bearing battle honours which they were proud to have a chance to wear once more. For the camp staff, the long months of preparation were over and, as the day wore on and things worked out smoothly, there was a sensation of relief.



Much thought had been given to the training programme, which was designed to cover as much of the technical ground as could be digested, flavoured with lectures on Current Affairs, the Geneva Conventions, Civil Defence and a demonstration by the Gunners of latest methods of causing casualties, some 12 per cent. of which, it is reckoned, will require resuscitation. Models were prepared to demonstrate the transport and deployment of the new transfusion supply organization in the field and a mock-up resuscitation ward set out in which the treatment of casualties from the front line to the base was demonstrated.

The Army Transfusion Service, built up during the last war, was second to none, but its *raison d'être* disappeared at the close of hostilities in 1945, soon after which it rapidly disintegrated. The large reserve of crystalloids and transfusion equipment was more than enough to meet peace-time needs for some time to come, while the National Blood Transfusion Service undertook the supply of whole blood to the army at home.

By 1948 these stocks had begun to deteriorate (along with the international situation) and the position was reviewed. It was decided that in a future emergency, the production of whole blood and plasma for the Services would be the responsibility of the National Blood Transfusion Service and that the remaining functions of the former Army Blood Supply Depot at Bristol would be adopted by the Army Vaccine Laboratory at Everleigh (since renamed the "David Bruce Laboratories" after the distinguished army pathologist General Bruce, who worked in its predecessors at Millbank and Netley). These functions would include the collection of whole blood and plasma from Regional Transfusion Centres for distribution to forces overseas; the production of crystalloids and transfusion equipment; training; and the mobilization of field transfusion units.

During the past eighteen months the army transfusion arrangements and field organization have been re-examined with special reference to the functions of the National Blood Transfusion Service, the David Bruce Laboratories and the Army Medical Equipment Depot. Proposals have been made for a new set-up for a Base Transfusion Unit. This is to be organized into a Headquarters and a Company (each with its Mobile Blood Bank) and two or more Forward Banks to provide storage facilities in the Corps maintenance areas, thus rendering the unit more flexible and adaptable to modern tactical conditions.

For this reason it was decided to take an early opportunity to train officers and men of the Reserve in the work of the transfusion service in the light of the proposed reorganization, and so the personnel of two Base Transfusion Units and a number of Field Transfusion Teams—some 160 officers and men—were recalled, for the first time in peace, as part of the Z reservist programme for 1952.

The fortnight culminated in a two-day exercise in the field (code name, Exercise "Dracula"), which was a good example of harmonious inter-Service co-operation embracing the National Blood Transfusion Service, the Royal Navy and the R.A.F. In brief, the exercise involved the deployment of the company of a Base Transfusion Unit and three Field Transfusion Teams (F.T.U.s. of the last war) to provide the transfusion service for an army, engaged in a

defensive role on the continent of Europe, for which South-West England did service. This proved the most popular part of the training, its success being due to the enthusiasm of those taking part and particularly to the ready co-operation of the sister services.

At the base was the headquarters of the Company with its four technical sections, viz., the Crystalloid Production Section ; the Equipment Servicing Section ; the Plasma Processing Section, and the Base Blood Collecting Section, all augmenting supplies from the United Kingdom which, so the legend went, had proved inadequate. It was served by an airfield near by from which supplies were flown by the R.A.F. in Ansons to the Forward Blood Bank, sited on an airstrip in the Corps maintenance area. Thence supplies were delivered by jeep and trailer to the casualty clearing stations and forward medical units. In the Divisional area was an Advanced Surgical Centre where a naval helicopter from Gosport demonstrated an effective method of supplying blood into the arms of the "recipient" by winch and hawser.

It was arranged that a number of Z men could hop lifts as air escorts which, by adding to the fun of the day, killed two birds with one stone. Over 100 pints of blood were taken from volunteers in the course of the exercise, so one might add that this was got out of the stone as well ! A number of points were brought out affecting the new organization, especially regarding the proposed staff and allocation of transport.

A visit by the Director-General and a number of senior officers was much appreciated by the reservists, who felt that their welfare was at the heart of the "powers that be." They all responded by doing their best—illustrating the tonic properties of "brass." Several transfusion pundits of the last war also gave up their time to come down and talk to the men, many of whom had served with them during the war and were glad of this opportunity of meeting again.

The fortnight was rounded off by a visit to Stonehenge as part of a "map-reading exercise" and, when the time came to say good-bye, the impression was gained that the camp had been an instructive and not unenjoyable experience.

As one frank Z man wrote, in a letter of appreciation : "I had visualized a completely wasted fortnight, but I can assure you, sir, I came away with a completely different opinion." With regard to the men undergoing training, he added : "They are certainly the type of men that helped to win the last war. They worked well as a team and, in the event of the balloon going up, I sincerely hope I will have the honour of serving with them again." This might be said to reflect the general spirit of a successful venture.

## *Matters of Interest*

### PAPERS BY R.A.M.C. OFFICERS

Cronk, Lieut. P. G. : Myocardial Calcification Associated with Pituitary Adenoma and Obesity. *Brit. med. J.* (1953), ii, 374-5.

MacFarlane, Major R. G., and Husain, Captain O. A. N. : Malaria in Servicemen. *Lancet*, (1953), ii, 677-8.

Marmion, Major D. E., Naylor, G. R. E., and Stewart, I. O. : Second Attacks of Typhoid Fever. *J. Hyg. (Cambridge)* (1953), 51, 260-267.

### A NOTE ON THE OFFICERS' PENSIONS SOCIETY

THE Officers' Pensions Society is an association of retired officers, widows, and the relatives of serving and retired officers. It was formed in 1946 with the objects of procuring improvement in retired pay and pensions of officers and their dependents, and promoting the interests of its members.

The Society is the only body comprising officer members of the three Armed Services, whose policy is controlled solely by its members. It is non-party, and the Members of its Council are unpaid. General The Lord Jeffreys is its President, and it has the active support of many distinguished officers of the three Services.

The recent increases in officers' widows' pensions, which had remained basically unaltered for over 100 years, and the abolition of the widows' Means Test were achieved by the efforts of the Society, the support of other Service associations, and the representations by Members of Parliament.

Officers have now realized the necessity of having an organization to represent their interests in these matters, and the Society's membership of over 6,700 is rapidly increasing.

Full particulars and membership application forms can be obtained from The General Secretary, Officers' Pensions Society Ltd., 79 Petty France, Westminster, London, S.W.1.

### THE ROYAL SOLDIERS' DAUGHTERS' SCHOOL

ATTENTION is directed to the existence of the above School. The School is situated in Hampstead, London, N.W.3, and is the only organization which caters solely for daughters of soldiers. It was founded nearly 100 years ago out of a sense of gratitude for what our Army did in the Crimea, and its purpose is to provide for the maintenance and education of the girls, particularly those

who have been orphaned. Applications are also accepted, as vacancies permit, from daughters of soldiers who are living, but who, for one reason or another, cannot provide for them. Consideration is also given to the daughters of soldiers serving abroad in countries where there is no suitable accommodation for families. Girls are accepted at the age of 5 years as boarders, and they can be kept at the school until the school leaving age (15). Their schooling is carried out by the London County Council, under the Ministry of Education, and particular attention is paid to a child's aptitudes and leanings in relation to her future. Parents or guardians are expected to contribute to the maintenance of children according to their means.

For full particulars write to The Secretary, Royal Soldiers' Daughters' School, 65 Rosslyn Hill, Hampstead, London, N.W.3.

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### *Book Reviews*

#### REPORT ON THE HEALTH OF THE ARMY, 1946-1948.

This is the first report on the Health of the Army since 1937, except for a statistical report which was published in 1948 and which gave tabulated data for the period 1943-1945.

The report is in its pre-war form, except that it is for a triennial, not an annual, period. This is not entirely a disadvantage. The report loses none of its interest by being for the longer period and trends in administration and the incidence of disease are easier to follow.

Chapters are given to Recruiting and Medical Categorization; Medical Aspects of Physical Training; Health Education; The Soldiers' Family; Military Personnel Research; The Army Health Organization and its Work (diseases of special interest are considered in this chapter); The Work of the Special Departments; and, lastly, Statistics.

The first chapter gives an interesting survey of progress in medical categorization, ending with the introduction on an inter-Service basis of the PULHEEMS System. The creation of a unified system of medical classification for the three Fighting Services is justly described as a notable achievement.

The chapter on Health Education gives an impressive summary of the measures which are taken to train officers and other ranks in the principles of health promotion. It is doubtful whether more is done for any body of people outside the Services, even when allowance is made for difficulties and shortcomings. Yet it must be confessed that the results often seem disappointingly meagre.

The extent to which the soldiers' ration was reduced both during the war and afterwards is rightly brought out. The Arneil Report of 1948 showed that the soldier at home supplemented his ration to the extent of 900 calories by purchases from canteens. One is glad to learn that there is no change in the

policy that the soldier should be provided with adequate rations to meet his requirements. The cuts were accepted only on the basis that the soldier in peace time could not be treated as a privileged person at the expense of civilians doing similar work.

Advances are recorded under the heading of accommodation. The revision of Barrack Synopsis, 1938, resulted, from the medical point of view, in great improvements in the new scales. But the report frankly admits the pressing need for modern married quarters, the shortage of which caused then, as it still does, much hardship to families.

Increasing awareness of industrial hazards led to the formation after the war of a permanent War Office Committee consisting of representatives of the three Fighting Services, the Ministry of Health, the Ministry of Supply, the Ministry of Labour and the Royal Army Medical College. This Committee has continued to meet regularly to the present time and acts in a valuable consultative capacity for the Services.

The period under review saw a further decline in the incidence of malaria and the change from mepacrine to paludrine as the standard prophylactic drug. The war-time malaria organization was wound up at this time, which was unfortunate in view of the need today for experience and guidance in the use of the many new insecticides.

During the Egyptian cholera epidemic, which began in September, 1947, the Army successfully demonstrated its faith in its own standards of hygiene. "It was not until 4th November, 1947, when the epidemic was rapidly declining and the hygiene battle was considered to have been won without a single British casualty, that mass inoculation was ordered to allay a not unnatural popular feeling of anxiety at home." The understatement of the last sentence seems to imply that any panic which was felt was not in Middle East, wherever else it may have been!

This is the last report in which the health of the Army in India will be mentioned. A brief note states that, in the last years of the British Army in India, sick rates had not yet returned to their pre-war level. This is attributed to continuing accommodation in temporary camps and to communal tension, which caused the employment of troops in conditions of intense heat and bad sanitation.

Chapter VII describes the work of the Special Departments and tells the sad story of the run-down after the war with the resulting shortage of trained personnel. This was most serious in the case of Surgery and "the picture during the three years was that of a steady decline from a first-class and fully-staffed specialist service in the R.A.M.C. to an over-stretched service of doctors with minimum specialist cover."

The section on Psychiatry is of particular interest, not least for the emphasis which it places on prophylaxis. The modern army calls for a high degree of technical skill from its soldiers, but 13 per cent. of the intake belong to the group which is lowest in terms of ability to learn. The description of how these men are dealt with is excellent.

The years of 1946-1948 covered the reorganization of the Pathology Services on a peace-time basis and the establishment of a peace-time Transfusion Service for the Army. Seven pages give an interesting account of how the high standard of Army pathology was maintained. The Army Tumour Registry and a Serology Laboratory were formed at the Royal Army Medical College; the Emergency Vaccine Laboratory was organized as an independent unit to prepare vaccines, diagnostic sera and crystalloids, while research work continued both at home and overseas. 1946 is the last year for which a report is given on the Pathological Services in India. A tribute is paid to India as a fertile training-ground for pathologists in the past; the development of Army pathology has been largely due to experience gained there.

Chapter VIII, which covers over fifty pages, deals with the statistics for the three years under review. It is divided into eight parts, each a storehouse of interesting material.

During the war, circumstances made it difficult to obtain routine morbidity rates and therefore the "Statistical Report on the Health of the Army, 1943-1945," mostly contained papers dealing with specific issues based on sample analyses of personal medical records.

A uniform system of documentation was introduced again towards the end of the war, upon which most of the tables in this report are based. The rates quoted now include all patients treated in medical reception stations as well as in hospitals, but exclude all out-patients and patients treated in medical centres. The introduction draws attention to the change in composition of the Army which must be borne in mind when making comparison with pre-war years; the inclusion in the rates of cases treated in medical centres must also be taken into consideration.

Much fascinating information is included in the Statistical chapter. The importance of skin diseases as a major source of sick wastage is brought out and also the creditable fact that in none of the big commands was malaria an important cause of admissions. The stabilization of conditions after the war is reflected in the progressive lowering of total admission rates; the exceptional rise in M.E.L.F. in 1948 is associated with the withdrawal from Palestine. Here, also, one learns that in 1946 45,000 dentures were supplied to Army personnel—a harsh comment on the dental fitness of the British people, and an answer to Mr. Churchill's impatience three years before with the loading of dental chairs for the invasion of North Africa.

Some minor errors appear in the report. In the section on Water Supplies, "ortho-toluidine" should read "ortho-tolidine." Regular R.A.M.C. ophthalmologists may well resent being described, on page 48, as "which". "T.B." and "V.D." are colloquial abbreviations and the plural "syllabi" on page 15 is pedantic. On page 75, "comparitively" should read "comparatively".

Taken all in all the report is the creditable record of a satisfactory achievement and well worth detailed study.

R. J. N.

**PARKINSON'S DISEASE AND ITS SURGICAL TREATMENT.** By Leslie C. Oliver, F.R.C.S. London: H. K. Lewis. 1953. Pp. viii+88. 12 illus. 12s. 6d.

When the surgery of involuntary movement is coming more and more to occupy the minds of the neuro-surgeons, it is refreshing to have Oliver's monograph on the surgical treatment of Parkinson's disease. He states bluntly that at the present time there is no cure for Parkinson's disease, but that in a small proportion of cases substantial improvement may be accomplished by surgery if great care is taken in the selection of patients. The monograph has been written chiefly to dispel exaggerated claims for surgery.

The present status of medical treatment is reviewed and then the various surgical procedures which have been undertaken in various neuro-surgical clinics are described. Oliver presents concise case summaries and results of the cases he has selected and treated by pyridotomy, complete section of the lateral column and by cortical undercutting. It is interesting to note that Oliver regards the commonest presenting symptom as disability, while tremor, though embarrassing, usually takes a subordinate place. The recognition of this fact is fundamental before surgical therapy is undertaken.

The material for this monograph was gathered from the examination of just over 1,000 cases with the Parkinson syndrome, 300 of whom were submitted to detailed neurological study. From this group 90 patients were selected for operation.

The book is clearly written and easily read. Each chapter contains a useful bibliography which will provide the interested reader with quick access to a wide range of previous papers on the subject.

W. S. L. and R. M. G.

**MALARIA TERMINOLOGY.** Report of a Drafting Committee Appointed by the World Health Organization: Sir Gordon Covell, C.I.E., M.D., Paul F. Russell, M.D., M.P.H., N. H. Swellengrebel, D.Sc. World Health Organization. Geneva.

In the space of 80 pages, of which half form a commentary and the other half a glossary, the terms used in relation to the parasite, human community and vector are discussed and elucidated, and the distinguished authors have clearly and concisely defined and explained much that has caused confusion and misunderstanding in the past.

The many notable contributions to the knowledge of malaria during the last decade have necessitated the publication of this present report and its timely appearance will be welcomed by all concerned with the clinical and epidemiological aspects of this disease.

The difficulty of deciding the names of the individual parasites at last appears to be solved. Those in common use have been adopted.

A certain amount of latitude is still permitted in connection with the names of the infections caused by the various species of parasite. Colloquial terms, such as B.T. and M.T. malaria, may still be retained, but the authors would

prefer that they were called "vivax" and "falciparum" respectively—a change which, if adopted by the Army, would at least require the amendment of A.F. W3166.

The demonstration of tissue phases in mammalian malaria has called for a revision of the terms employed to describe the use and action of antimalarial drugs and a list of suggestions is given which, though exact, are unwieldy for everyday use.

Purists will be relieved at last to know when and in what sense the words "anopheles", "anopheline" and "malaria", "malarial" should be used for descriptive purposes.

A short review cannot do justice to this excellent monograph which crystallizes in most easily understood language our present knowledge of malaria.

T. M. W. d'A.

**MEDICAL HISTORY OF THE SECOND WORLD WAR : MEDICAL RESEARCH.** Edited by F. H. K. Green and Sir Gordon Covell. London : H.M.S.O. 1953. Pp. xvi+387. 40s.

This very readable book describes the many medical research projects which were undertaken during the war years.

There can be no specialist who will fail to find an interesting and authoritative account of the advances in his own subject, with an excellent bibliography.

For the general reader the great diversity of the material—from the development of penicillin to the effects of blast, touching on nearly every aspect of medicine and surgery, has resulted in a book which can be recommended without hesitation.

J. A. H. B.

**PULMONARY TUBERCULOSIS : A Handbook for Students and Practitioners.** By R. Y. Keers, M.D., F.R.C.P. (Edin.), F.R.F.P.S. (Glas.), F.R.S.E., and B. G. Rigden, M.R.C.S. (Eng.), L.R.C.P. (Lond.). Edinburgh : Livingstone. 24s.

This is the book which should be read and re-read by all senior medical students and by those recent graduates who intend specializing in pulmonary tuberculosis. It is an excellent book containing as it does fruits of Midhurst and pearls from Tor Na Dee. To dwell on its good points would be superfluous, but I might mention that in its approach to the minimal lesion, the indications for surgery, and the attitude to pulmonary tuberculosis in the pregnant female it could be read with advantage by consultants in this field. It can be improved essentially by what it has omitted. The value—really, the imperative necessity—of full-plate A.P. and lateral tomography frequently combined with zonal tomography in gaining a reasonably fair appreciation of the extent and character of the disease must be emphasized. Also the value of screening every patient and noting the movements of the diaphragm on full respiration and on sniffing.

Surely it is superfluous to state that the sedimentation rate is not a specific



test for tuberculosis? Other, and frequently associated, causes for elevation of the S.R. should have been mentioned.

Dionosil oily should remove some of the objections to bronchography in certain cases.

The term atypical pneumonia is useless, meaningless, confusing and should be omitted, while the battery of serological tests carried out as a routine, in modern clinics, in cases of pneumonia of indeterminate origin should have been mentioned.

In all cases of lung abscess of obscure origin it is considered prudent these days, even in the absence of a history of amœbiasis and even where *E. histolytica* has not been isolated, to consider a course of emetine or chloroquin.

In mediastinal masses the value of deep X-ray in diagnosis seems to have been omitted.

The incidence and mortality of pulmonary tuberculosis in Scotland compared with England and Wales is no mystery. Scotland's slum problem is six times greater than England's.

In Brucellosis the serological reaction may be persistently negative in established cases.

The place of A.P. therapy is not what it was, but it has been proved that it is not reasonable to abandon an A.P. in the presence of indivisible adhesions where selective collapse has been obtained.

Sequelæ of left phrenic crush include flatulent abdominal distension and severe constipation.

This has the makings of a great book—the best of its kind—and the authors can make it so next time.

J. M-D.

THE DISPOSAL OF THE DEAD. By C. J. Polson, M.D. (Birm.), F.R.C.P., R. P. Brittain, M.A., B.Sc., M.B., Ch.B., B.L., LL.B. (Glasgow), and T. K. Marshall, M.B., Ch.B. (Leeds). London: English Universities Press. 1953. Pp. xii+300. 21s.

The authors have set out to present in a single volume a conspectus of knowledge, legal, religious and medical, bearing upon the disposal of the dead, the duties of the medical practitioner, registrar of births and deaths, coroner, police, clergy and undertaker all being covered in a logical, practical and readable manner. The military pathologist will find the answers to many problems, e.g., disposal of still-births and removal of a body to another country, while abroad he may well be glad of the detailed directions for embalming. He will certainly be the better for reading this book, and he will be interested in the authors' contention that any autopsy not performed under a coroner's order is probably illegal.

The authors have allowed their obvious bias in favour of cremation to produce some imbalance in the text—few readers will need to know the number of cremations in 1951 in every British crematorium from Aberdeen to Woking,

or the address of the national cremation society in every country from Iceland to the Argentine. References should be presented in more uniform fashion—some are listed at the end of the chapter, others are given in footnotes, others again in the text. But however it is done—and the best way would probably be to collate them, part by part, at the end of the book—the irritating and time-wasting *loc. cit.* should be eliminated.

J. B. N.

LOCAL ANALGESIA : ABDOMINAL SURGERY. By R. R. Macintosh, M.A., D.M., F.R.C.S. (Edin.), D.A., and R. Bryce-Smith, M.A., B.M., B.Ch., D.A. Edinburgh : Livingstone. 1953. Pp. 94, 88 Figs. 22s. 6d.

Local analgesia, alone or with a light general anæsthetic, can provide ideal operating conditions. Its use requires time and skill. Since the introduction of the muscle relaxants with their ease of administration and speed of action, local analgesia for abdominal surgery has been taught and practised less. Yet, as the authors point out, there are still indications for its use, not only in surgery, but also in diagnosis and treatment.

After a general introduction plus consideration of pain pathways and sensory innervation of the viscera, the anatomy is *described* briefly but in sufficient detail to provide a clear picture, followed by a simple but accurate account of the techniques of the various blocks. The numerous illustrations are excellent and fit in well with the text.

This book would make a most useful addition to the library of an Army surgeon or anæsthetist, as all the information and detail necessary for the practical application of these procedures is presented briefly but clearly.

S. O. B.

TRICHLORETHYLENE ANÆSTHESIA. By Gordon Ostlere, M.A., M.B., B.Chir., D.A. Edinburgh : Livingstone. 1953. Pp. vii+83. 7s. 6d.

Since Langton Howe's first report in 1941, trichlorethylene has been regularly used in this country. At first a number of difficulties and dangers were encountered, but now that greater experience has been gained, an assessment of its uses and limitations can be made. In this interesting and instructive book such an assessment has been carried out, and it enables the reader to clarify his ideas about trichlorethylene and its limitations, and to reassure himself of its safety when used properly.

The book is well arranged and, if it lacks detail in the practical administration of the drug, does give a good review of its use in analgesia for midwifery.

S. O. B.

## EDITORIAL NOTICES

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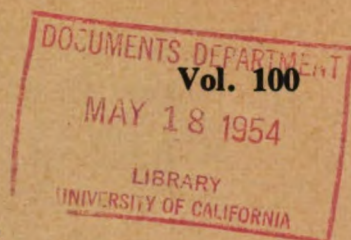
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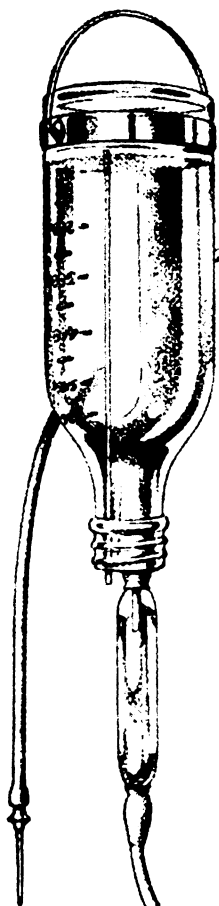
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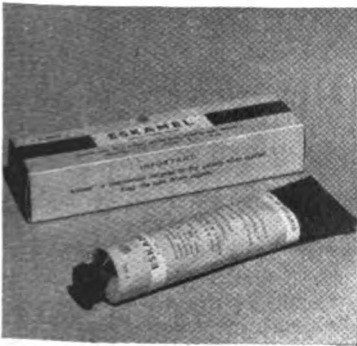
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## *Original Communications*

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### THE KNAPSACK AND PACK

AN HISTORICAL AND PHYSIOLOGICAL SURVEY WITH PARTICULAR  
REFERENCE TO THE BRITISH SOLDIER

BY

E. T. RENBOURN, B.Sc., M.D.

*Formerly Major, Royal Army Medical Corps*

*Ministry of Supply: Physiological Research Establishment of the  
Directorate of Physiological and Biological Research*

### PART II

*(Continued from page 15, January issue)*

#### EARLY TWENTIETH CENTURY

At the turn of the century, Zunz and Schumburg in Germany commenced their classic work on the energy expenditure of military load carriage, and the results were published in 1901 (29). The effect of a load on respiratory function was investigated; and it was shown that a load of 48 lb. decreased the vital capacity (respiratory efficiency) by 9 per cent., and one of 59 lb. by 11 per cent. It was demonstrated that the energy cost of marching increased almost proportionally to the mass moved; but with loads over 45 per cent. of the body weight, the metabolic cost rose disproportionately. Asymmetry of loading was shown to produce a triple increase of energy cost. Thus a rifle of 9 lb. slung over one shoulder was said to produce the same oxygen utilization as a weight of about 27 lb. in the pack. It was stressed that the carrying of heavy loads could lead to

venous engorgement of the kidney and lungs, to emphysema and dilatation of the heart; but such observations would, however, not be acceptable nowadays (32).

A notable landmark in the history of American Military Hygiene was the publication in 1901 of a textbook by Captain, later Colonel, Munson (30). In the chapter on Military Clothing and Equipment, we find a surprising wealth of information on the work done by Pettenkofer (31), Laveran (28), and other hygienists on the physiology of clothing. The section on the various aspects of load carriage by the soldier is done so well that it is doubtful if it could nowadays be improved upon, and it is not surprising that little has been added to the practical aspects of the problem. The contemporary American "Blanket Roll" and "Blanket Bag" came up for criticism, and a description of the British valise equipment of 1871 is given, as well as that of two new American patterns.

We are told that during the American Civil War of 1861-1865, the soldiers soon discarded their uncomfortable and heavy knapsacks, and carried the "Essentials" rolled in a blanket and slung over the shoulder. This was the origin of the regulation Blanket Roll, converted later into the Blanket Bag. According to Munson, neither the Roll nor the Bag was based on any sound principles. He added that "the Blanket Bag is the most vicious article in the equipment of the American soldier, . . . troops throw it away if hard pressed." It is noted that the British equipment was tried out by the American First Army Corps in 1896, with the following unfortunate conclusion: "(1) When packed the valise is convex at the back, and is therefore constantly wobbling; (2) without ball ammunition it is badly balanced; (3) practically the whole strain comes on the braces, which cut into the shoulder and check lung expansion; (4) the weight is so distributed that the heaviest portion, *i.e.*, the great-coat, is carried on the waist and drags on the loins; (5) equipment cannot be taken off and put on quickly without assistance; (6) all the drawbacks are emphasized on a small man." According to Munson, the equipment produced by General Merriam in America was far superior to the British valise equipment. It is of interest to note that mention was already made of the value of aluminium for use in the mess kit.

A description is given by Munson of the "Irritable Heart" or "Heart Strain" of the soldier, as described by Da Costa in 1871. It was clearly realized in America that some of the symptoms of "Pack Exhaustion" (pain in the chest, shortness of breath, weakness, dizziness, irregular pulse and collapse) were due to the "Irritable Heart"—a functional disorder—and not to valvular disease, heart failure, or to the heart "corn" of McLean. The present attitude to the effect of severe exertion on the heart and lungs is well reviewed by Abrahams (32).

An excellent monograph on military load carriage, from the viewpoint of the practical soldier, was published in 1902 by Commandant Lavis (33) of the French Army. This gave a detailed description, with diagrams, of the various forms of personal load carriage equipment used by the American and by the various European armies, and available at the turn of the century. The British equipment described is obviously the 1888 pattern. There is a critical discussion

of the total load, the comparative merit of high and low knapsacks, and the relative values of using the shoulders and hips in taking the weight. We are told that the knapsack was carried very high on the back by the French, Spanish and Italian armies; and that the weight was carried using both the shoulders and hips by the German, Austrian, English and Dutch soldiers. It was clearly realized by Lavissee that, in order to have stability with a high pack, supporting straps passing into the armpit were unavoidable, with consequent pressure on the blood-vessels and nerves of the arms. Lavissee himself was strongly in favour of a long, narrow, flat pack lying in the axis of the spine, supported by the hips (through the belt) and shoulders, and with the weight of the pouches balanced by the pack behind. It seems clear that Lavissee had predicted, by some fifty years, the principle in design of the British 1951 experimental web equipment.

With the Boer War of 1899-1902, tactics had to be improvised to deal with the fast-moving Boer commandos, and mobility of the soldier was now the order of the day. In the 1903 Report of His Majesty's Royal Commission on the War in South Africa, it was pointed out by Lord Elgin that Lord Kitchener had said of this campaign: "Our losses in ammunition, which itself proved a source of supply to the enemy, cannot be ascribed to want of care of the individual soldier, as much as the peculiar unsuitability of articles supplied to him, in which to carry his rounds." We are also told that in the opinion of Sir Charles Warren, "the knapsack or valise supplied was an absurdity." One commanding officer of an infantry battalion said that "the accoutrements were cumbersome, heavy and badly balanced." In imitation of the Boers, and in an attempt to prevent the loss of ammunition on the run, a bandolier (with 50 rounds), discarded in about 1680, was reintroduced. Brown leather at last replaced the buff "Slade-Wallace," and for the first time webbing began to make its appearance. The valise itself was completely discarded as being unsuitable; and the marching soldier normally carried only his arms and ammunition, water-bottle and haversack—a total of about 25 lb. Under these conditions a General's dream of an army of Light Infantry was actually realized. In 1903 there was an observation by Dr. Harvey Cushing (later the eminent brain surgeon) that rifle or pack drill could produce pain, weakness or numbness of the arms or hands, due to pressure on the nerves and blood-vessels passing under the clavicle (34). This condition of "Pack Palsy" was, however, already known to Pringle in 1752.

#### COMMITTEE OF 1906-1908 : 1908 EQUIPMENT—PHYSIOLOGICAL TRIALS

Between 1906 and 1908 there were four meetings of the Committee on Physiological Effects of Food, Training and Clothing of the Soldier, the chairman of which was Surgeon General Sir Alfred Keogh. Most of the members were physiologists or medical men, and amongst them were illustrious names such as Sir Frederick Treves, the surgeon (who had played a valuable role in the Transvaal War), Professor J. S. Haldane, and Professor M. S. Pembrey. The secretary was a Captain Parker, R.A.M.C. The constitution of the Committee thus somewhat resembled that of the present M.P.R.C. of the War Office.

During the early days of the Committee, Major Burrowes, of the Royal Irish Fusiliers, had been collaborating with the Mills Web Equipment Company in producing the "Aldershot Design," later to be known as the "1908 Web Equipment." This pattern was placed before the Equipment Sub-Committee for examination. One fault of the previous equipments of 1871, 1882 and 1888 was that balance of the load between front and back was present only when the front pouches were filled; and when these were empty, the shoulders were pulled back and the belt was dragged upwards by the weight of the pack behind. According to the designers, the new principle allowed of a balance whether the pouches were empty or not; and this was brought about by a strap passing from below the ammunition pouches and diagonally across the back of the pack to its opposite and upper corner. A virtue of the new equipment was its good balance, which allowed the belt and jacket to be unbuckled during the march. However, we have noted that this particular virtue had already been claimed for the equipment of 1871. The load-carrying equipment was now for the first time made entirely of webbing, and was thus more pliable and adjustable than one of leather. The pack, whether large or small, was carried below the shoulder level, and lower on the back than the knapsack before 1871 or the valise of 1882-1888. The ammunition load of 150 rounds was distributed between the five pockets, which on each side constituted the new ammunition pouch. As in the case of the 1888 "Slade-Wallace" equipment, there were no constricting straps in the armpit. The whole equipment could be put on and removed in one piece.

Among the numerous trials done on this equipment there was one on the physiological aspects, carried out by Professor Pembrey and Captain Parker. The objective measurements used were sweat loss from the body and sweat retention of the garments during a seven-mile march. However, only two subjects were used at a time, and on occasion the Professor was included for good measure. The 1903 equipment, with belt buckled and tunic buttoned up, was compared with the new equipment with the belt unbuckled and shirt and tunic open, the load carried being approximately the same (both Drill and Marching Order were taken into consideration). As expected, with the belt and jacket undone, evidence was found of increased cooling, as shown by a decreased retention of sweat in the clothing. Since, however, the various experiments were done on days of different weather, and furthermore since the subjects were few in number, it is difficult to draw clear-cut conclusions as to the significance of the small differences found in sweat loss between the equipments.

In the Minutes of the Committee it is noted that: "With the old equipment it was necessary to keep the belt fastened, and in full Marching Order it had to be fastened tightly, otherwise the belt was dragged up by the weight of the great-coat behind. It is exceedingly common to see men during a route march in full Marching Order with the old equipment, jerking forward the body to relieve the pressure of the belt on the lower part of the chest. The bandolier with its ammunition is borne largely by the chest, and has to be raised with each breath. Due to its ingenious design, the new equipment is free of all these defects, and can be loosened or unclasped on the march. With the full complement of load,

both new or old equipment are excessive for the young recruit." The Committee referred to the perennial problem of a sweating back, and to the use of triangles, frames, and pads, all of which had been found useless. The fact was stressed that, for the load to be stable during "the double," it had to be closely applied to the back, with consequent poor ventilation. It was, however, pointed out (as had been done with most earlier equipments) that, with suitable adjustment of straps, some ventilation of the back could be obtained.

#### MILITARY HYGIENISTS, 1908-1914

Firth in his textbook published in 1908 said of the issue (1903) equipment : "It is light and simple ; its most objectionable feature is the bandolier which, when loaded, presses heavily on the chest" (35). He spoke of a new equipment without a bandolier which allowed the belt to be unbuckled on the march, and of a trial carried out on a rucksack pattern. Commenting on the 1903 equipment, Melville said in 1912 : "The bandolier was in use lately in our own army. . . . This method is the worst possible from the physiological point of view . . . it hampers every respiration and greatly impedes evaporation from the chest" (36). Strangely enough, the 1908 web equipment received no mention.

A later book, by Colonel Havard of the American Medical Corps, discussed briefly the problems of load carriage ; and although published in 1914, delineated the 1903 pattern as the issue British equipment (37). Keefer in his textbook on Military Hygiene, published in 1914, still described the British 1888 equipment as the contemporary method of carrying loads (38). It is obvious that up to the First World War, knowledge of contemporary equipment, and the problems of load carriage, was not as extensive as it had been amongst the Military Hygienists towards the turn of the century. During the period 1912-1914, Brezina, Kolmer and Reichel published their work on load carriage by the soldier, and showed that with loads of more than 19 kilos (42 lb.) there was a disproportionate rise in energy cost, as measured by oxygen consumption (39, 40). It is of some interest to note the use of statistical methods by these early workers.

#### FIRST WORLD WAR, 1914-1918 : THE LOAD CARRIED

With the onset of the 1914 war, the British soldier went into active service with the 1908 equipment, but owing to insufficient supply of web material, leather was used for all parts except pack and haversack. The total weight of equipment carried by the soldier in Marching Order had been reduced to 54 lb. in 1907, but rose to about 60 lb. by the beginning of the war. This latter figure was, in fact, simply a base line, which steadily rose as the war progressed. Because of the extra requirements in clothing, and the introduction of new offensive weapons and of defensive equipment (steel helmet and respirator of 1916), the weight increased to about 74 lb. in summer and to about 80 lb. in winter. And this was not all. The soaked great-coat contained up to 20 lb. of water, and water and mud on the rest of the clothing and equipment gave the possibility of a further 14 lb. Although transport was sometimes available, the



infantry soldier often carried up to 85 per cent. of his own weight, and was of course expected to fight at the end of a march. The soldier was now carrying on his person a load greater than he had ever borne at any time in history, and as a result marches of more than five to seven miles a day were never carried out in France with fully accoutred soldiers. At Cambrai, in November, 1917, the British infantry, exhausted by their great loads after an advance of about five miles, were unable to consolidate the positions opened for them by the first and historic mass attack by tanks. Lothian suggests that it is unlikely that either the renowned Greek Hoplite or the Roman Legionary carried on his person during the march more than about 55 lb. (41). It is true that porters in the East have for long carried loads up to 200 lb., but they do not fight, they walk at their own pace, and rest when they wish. In France, the infantry soldier had become far worse off than the pack animal, who is carefully tended and rarely allowed to carry more than about one-quarter of the body weight. Thus, figures generally accepted for such animals are : camel, cavalry horse or mule 25 per cent. and elephant 15 per cent. of the body weight.

During the First World War the German physician Rumpel showed in 1916 that long marches with heavy loads produced in a high percentage of soldiers changes in the urine (albumin and urinary casts) normally diagnosed as arising from kidney disease. A similar statement was made much earlier by Thurn in 1872 (42), and later by Collier in 1906 (43). The work of the Harvard Fatigue Laboratory during the Second World War confirmed the observations. It is, however, now known that the changes are transitory, and due in part to an exaggeration of the physiological decrease in blood supply of the kidney, with an increase in its water re-absorption, occurring during exercise and overheating of the body.

#### CATHCART SCHOOL AND CHEYNE, 1919-1926 : ENERGY EXPENDITURE STUDIES

After the end of the war the physiologists Cathcart and Orr (44) published a report on the "Energy Requirement of the Infantry Recruit in Training." They pointed out that continental armies carried loads high up on the back, and this necessitated a forward stoop associated with a constant hitching up of the load. In order to assess the most suitable position on the back for a load, they carried out a series of preliminary experiments on energy expenditure, using a constant total weight, but with differences in symmetry of loading and of position of the pack on the back. Their results suggested that a considerable latitude could be allowed in the way a given weight was carried, and this did not appear to bear out the earlier findings of Zunz and Schumburg on the effect of asymmetric loading. It was also stated by Cathcart and Orr that "the high position for a pack does undoubtedly reduce the expenditure of energy, and we may assume that the load is carried more easily." The former statement, however, does not appear to be borne out by the data presented. Some preliminary experiments were also carried out on the physiological maximum load, and this appeared to be in the neighbourhood of 45 per cent. of the body weight.

After the 1914-1918 war, the "Army Hygiene Advisory Committee" continued its activities, and Professor Cathcart as a member maintained active interest in the problem of load carriage. During the war, many complaints had accumulated on the poor balance of the 1914 equipment. This necessitated leaning forwards with a tight belt to prevent the pack slipping down, with a consequent drag on the belt. The age-old criticism of the shoulders being pulled back was brought up again. In order to overcome these perennial defects, and to decrease the wobble of the pack, Cathcart and Lothian (on the suggestion of Major Johnston Stirling, R.A.M.C.) introduced in 1923 two modifications of the 1914 equipment, viz. (1) attachment of the pack to the shoulder straps, near the midline of the pack and about one-third from its top border (as in a rucksack), and (2) supporting straps passing from just above the pouches in front, to the lower angles of the pack below. It will be noted that similar supporting straps were already present in the 1871 and 1882 equipments (Fig. 3). The first modification had already been suggested forty years previously by the 1879-1881 Committee.

Using such modifications, laboratory experiments were carried out by Cathcart and Lothian, and the results showed an apparent saving of 17 per cent. in energy cost during marching (45). With judicious adjustment of straps, the pack fell away a little from the body, giving some ventilation of the back. It was also asserted that "whether an equipment is good or bad can be judged by (a) its appearance and movement during work, (b) the feelings of the man carrying the load, and (c) the energy expenditure in carrying the load. As regards (a) and (b) there may be difference of opinion, but the estimation of the energy expenditure should prove an unfailing guide as to the best form of equipment, and the best distribution of the load" (45). This last statement will be taken up again later. It is to be noted that nothing came of the results of the experiments, or the suggestions put forward by the physiologists.

During 1923 appeared the classic work of Cathcart, Richardson and Campbell on the relationship of load carried by the soldier to the energy consumption (46). They showed that the maximum load for maintenance of efficiency and health under laboratory conditions was about 40 per cent. of the nude body weight, and for Service conditions accepted the traditional one-third body weight. Although the work was done with great care and accuracy, only two experimental subjects were used (Richardson and Campbell), and the experiments were done solely under laboratory conditions. It is obvious that under field conditions of prolonged activity, bad weather and terrain, with poor sleep, little rest and insufficient food, the figure may be appreciably less than one-third of the body weight. It is furthermore an acceptable truism that the optimum economic load to be carried by the fighting soldier is no load at all. However, the figure of one-third has become more or less generally accepted as the maximum load compatible with efficiency; and as such it corresponds to that laid down independently by military writers such as Von Plonnies and Thurnwald during the end of the nineteenth century, to the results of the physiological researches of Zunz and Schumburg, and later to those of Brezina, Kolmer and Reichel (39, 40).

In 1924 there appeared a paper by Bedale (47) on the load carried by women in industry. Of the eight different methods of carrying a load that were examined, yoke carriage of the milkmaid was found to be the most efficient, from the viewpoint of energy expenditure, with loads of 20 to 50 lb. It was also shown that load carriage on the back by a rucksack was often as efficient as carrying the load on the head. The point is made here, because it is still often assumed that the latter is a very efficient method ; but this is probably true only after a very prolonged period of training. Evidence from the data in the paper suggested that for most forms of load carriage there is a proportional rise in energy expenditure for loads over 40 lb. However, the data were derived from only one female subject.

Another report on load carriage by the soldier was published in 1926 by Captain Cheyne, R.A.M.C. (48), who had followed up the earlier suggestion of Cathcart and Orr as to the value of a high position for loads on the back. He agreed that a high position produces a slight stoop forward, but since most of the respiratory movement in a man takes place in the lower part of the chest, this high position would *per se* not impair breathing efficiency. Cheyne believed that the fault of the 1908 pack was due to its being carried below the shoulder level, to the tendency of the shoulder strap to slip down the shoulders, and hence for the pack to lose its stability. As with Cathcart and Lothian, he suggested that the points of attachment to the upper part of the pack be central and below the upper border. This would prevent slipping of the shoulder straps, bring these closer to the root of the neck, and allow a high position for the pack on the back. In order to produce stability in this position, supporting straps were passed from just above the ammunition pouches in front to the belt at the back. The attachment was not made to the lower angle of the pack (as done by Cathcart and Lothian), because with the high position of the load the supporting straps would have to pass high up in the armpit. Cheyne believed that with a high position and small pack, the armpit tends to be compressed by the supporting straps. Using his modifications, he carried out experiments on 15 men marching in a laboratory, and claimed a saving of about 13 per cent. in energy expenditure. Together with this there was greater comfort in marching, and an increased cooling of the back.

#### BRAITHEWAITE COMMITTEE, 1953 : 1937 EQUIPMENT

Little active research was done on the problem of load and equipment during the peace years of 1926-1934, but Atzler published his monograph on the Physiology of Work in 1927 (49), and the results of Crowden's investigation on load transport in the brick industry appeared in 1928 (50). In 1935 the Braithewaite Committee on the Dress and Equipment of the Infantry Soldier was set up, with Major-General Henderson, Director of Hygiene, as medical representative. During the meetings it was pointed out that "the experience of the Great War had shown notably that the infantry soldier had been definitely overloaded, and few if any instances had come to light of his running out of ammunition." It was stated that the average peace-time weight of the soldier

could be taken as 135 lb., and that, if practicable, not more than one-third of the body weight be carried as a load. Fifty rounds were suggested as suitable for Marching Order, and 100 for Battle Order. Recommendations were put forward for the pack to be carried high on the shoulders, with no equipment below the waist. It was noted that "a new improved design of web equipment was under way, and that this would allow of greater comfort, and permit the buckle to be unfastened on the march." This perennial claim had been put forward for all equipments from 1865 onwards, only to be retracted before the appearance of a new pattern.

In 1937 the new equipment produced by the Mills Company came into official use. It had the advantage of being lighter than the 1908, and adapted to suit different arms. There was no large pack for Battle Order, but instead a roomy haversack as it was anticipated that the large pack (1908 pattern) would normally be carried in regimental transport.

#### SECOND WORLD WAR, 1939-1945 : PHYSIOLOGICAL TRIALS

During the Second World War the 1937 web equipment was used generally in all theatres of war. Some time in 1942 a completely new design in personal load carriage equipment was being put forward by Colonel Rivers-Macpherson, Chief Ordnance Officer of the Field Stores, Aldershot. He stated that "web equipment was the high spot of its day, when the tempo of attack was infinitely slower than that of today, but one can say without hesitation that basically web equipment was no advance on what had been worn 100 years ago." All forms of web equipment having a waist belt came up for criticism, in part for the medical consideration that they "press on the duodenum." In point of fact, this part of the small bowel is well sheltered by the liver, and in part by the stomach itself. It was also stated that "the Trapezius weight-carrying muscle has been designed by nature, to carry heavy loads." Apart from teleological implications, the Trapezius acts mainly in keeping the shoulder girdle in position ; and during the carriage of heavy loads by professional porters, the weight is mainly supported by the pelvis, and by the back with its ligaments and extensor muscles. As an improvement on the issue equipment, Rivers-Macpherson put forward the battle jerkin (51), based on the poacher's jacket. Small scale trials were carried out on this pattern, and as a result it was suggested that it replace the 1937 equipment.

In August, 1942, a physiological trial was carried out on the battle jerkin and 1937 equipment by the Hygiene department of the Royal Army Medical College. Six soldiers were used, carrying 45 per cent. of the body weight, in marches of four hours' duration. The following measurements were taken : (1) Energy expenditure, (2) vital capacity, (3) respiratory rate, (4) pulse rate, (5) recovery period. Little difference was found between the equipments in any of these measurements. During the period of trial the external conditions varied from 45° F. to 57° F. (relative humidity not given) ; and since the equipments were not randomized between the various days, it would have been difficult to draw valid conclusions even if appreciable difference had been found.

In spite of this, it was concluded that certain results were in favour of the battle jerkin. Other trials suggested that the stiffened waterproofed cotton duck of the jerkin made a man hotter than did the 1937 equipment, but this assertion was never clearly proved. In order to fit all men, three sizes of jerkin were necessary, and this brought up problems of replacement. Later in 1944 a skeleton type of battle jerkin was produced. But apart from the battle jerkin being used in localized theatres of war, the principle was dropped until taken up again after the war by the Canadian Army and by the Ministry of Supply.

During the war the old problem of the maximum load to be carried by the soldier was reviewed again, and in 1942 a field trial was carried out by the War Office Department of Hygiene (52). As in the trials of the 1879-1881 Committee, rifle fire was used as an objective test of the fighting efficiency of the soldier, but with the difference that the accuracy of the fire was now measured. Other objective tests used in the trial were the time taken to traverse an assault course and the time of recovery of the pulse and respiration. The weights carried by the men varied from 23 to 43 per cent. of the body weight. The external conditions varied from 59° F. to 70° F. with relative humidities of 52 to 95 per cent. It is stated in the report that "it would seem, therefore, that at 40 per cent. of the body weight, the soldier reaches the absolute maximum load to be carried into action." However, although this conclusion is suggested by superficial examination of the tables, a closer scrutiny reveals that the learning factor, as well as the varying weather conditions, played a part in the results. Since the experiment was not designed (as admitted in the conclusions) to eliminate such factors, the conclusions are hardly warranted.

As a result of the Lethbridge Mission to the Far East towards the end of the war, decisions were taken to modify the 1937 equipment for use in jungle warfare. Basically, the new equipment so produced—the 1944 web equipment—is the same as the 1937, but with the web thinner, lighter and more pliable, and with wider shoulder straps. An aluminium water-bottle was now introduced (as suggested by Munson in 1901). Modifications were developed to overcome the various criticisms of the 1937 equipment raised during the war, both in trials and during active field service. It was claimed that the new method of support allowed the basic pouches to be stabilized without a counter-balance on the back. After a number of trials carried out during the period 1946-1948 it was concluded, however, that the new design, even with modification, was inferior to the 1937 pattern; and as in the past, the shoulders were pulled back and the belt dragged up over the abdomen. An obvious disadvantage in both 1937 and 1944 patterns is the presence of the supporting strap passing high in the armpit when a small pack is carried high on the back. In addition, the 1944 equipment shows a return to the use of a chest strap (albeit loose), so condemned by Professor Parkes and the Committee of 1865-1868 (Fig. 3).

A valuable paper on the physiological background of load carriage by man pack was produced in 1944 by the Middle East W.T.C. Mountain Wing (53). This analysed both the static and dynamic forces concerned in load carriage, and pointed out that web equipment was unsuitable for loads over 20 lb., owing

to the marked tension on the shoulder straps. A paper on very similar lines and conclusions was published in 1950 by Colonel Kapur of the Indian Army (54).

In 1947, the Operational Research Section (India) published a report by Newsome and Singh on the relationship between the weight of the soldier, the load carried by man pack, the distance marched, efficiency and fatigue (55). The Havard Pack Test (56) was used as an index of general "efficiency" of the soldier, and "fatigue" derived from scores obtained before and after exertion. However, it is not clear that either of such measurements is valid (57, 58). The experimental subjects carried randomized loads during marches of five and seven miles. Since, however, the trial was not designed to eliminate either learning factors, acclimatization or varying weather, it was not possible to draw clear-cut conclusions as to the effect on the man of either the weight of the load or the distance marched.

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*End of Part II.*

*(To be continued)*

## THE PRINCIPLES OF PREVENTION OF COLD INJURIES

NOTES ON THE PROBLEM AS ENCOUNTERED, AND THE  
METHODS USED, IN KOREA

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[This paper has been written without reference to standard works or recent publications, only those published locally being available to the writer at the time. An attempt is made, however, to summarize, discuss and correlate current trends of thought on this subject, and to interpret these in the light of experience gained in Korea.]

### DEFINITION

COLD injuries may be defined as local lesions, usually of the extremities, directly or indirectly due to cold which would not occur under similar circumstances in temperate climates; this paper will be largely concerned with cold injuries of the feet.

Such lesions are known by a variety of names, *e.g.*, immersion foot, shelter foot, trench foot, and frostbite; and at times the differential diagnosis between the various types may be quite difficult. A true case of frostbite is not difficult to distinguish from a thorough-going trench foot, which in turn can easily be distinguished from a simple case of hyperidrotic maceration. There are, however, innumerable intermediate grades between these three types of case,

depending on the relative extent to which cold and moisture have played their part in causation.

### CLINICAL FEATURES AND PATHOLOGY

It is outside the scope of the paper to discuss in detail the clinical and pathological processes which occur, but some brief observations are indicated.

In temperate climates, the reddened, tender, but not much swollen foot, usually heels, soles, under-surfaces of toes and interdigital clefts affected, is well known. This is a result of the effects of moisture on the skin, usually excessive sweat retained in the sock continuously in contact with the skin over a period of months, and is due to localized capillary dilatation.

Should the temperature be lower under similar circumstances, *e.g.*, between 0° and 10° C. (32°-50° F.)—"wet-cold" condition—the effect is more severe; the typical trench foot is seen. Usually the patient has been standing in mud for some time, and his foot is wet either from water leaking through or over the tops of his boots, or from accumulated sweat, and the capillary damage is much greater. The affected areas at first become red and cold, and then, in the pre-hyperæmic stage, acquire a sickly whitish-yellow colour and swell slightly. After removal from the wet-cold condition, this stage persists for a few hours, after which the hyperæmic stage commences; affected areas become dusky red, more swollen, tense and shiny, and may vesiculate. The skin is hot, painful, and exceedingly tender; and, depending on the degree of vascular damage produced by the ischæmia of the prehyperæmic stage, the affected tissues may return to normal over a period of days, weeks or months, or necrosis of tissue distal to the point or plane of occlusion may occur.

Immersion foot, due to prolonged immersion of the lower limb, as seen in shipwrecked sailors or paddy-field workers, follows a somewhat similar course, the only difference lying in the time factors, which depend on the temperature of the water. The condition may take more than six weeks to develop in tropical paddy-field workers, or less than twenty-four hours in northern latitudes at sea.

True frostbite, however, requires little or no moisture for its causation; true freezing of affected areas takes place which, if the patient remains in the cold environment, progresses more widely and deeply. On withdrawal from cold, thawing having occurred, the effects of vascular damage are again seen; painful dusky red swelling of the part with vesiculation. In the same way, depending on the degree of vascular damage, the tissues either return to normal or necrose.

It should be added that the plane of demarcation which occurs at first is not the final plane; much of the proximal part of the lesion will be found to be superficial. Re-establishment of circulation from tissue proximal to that affected is fairly rapid, and if necrosis has occurred a final plane of demarcation six weeks from the time of injury is always much more distal than initial appearances implied.

In other words, all the above conditions appear to have a common patho-



genesis; a period of local ischæmia as a result of different combinations of cold and moisture is followed by evidence of various degrees of vascular damage.

### THE THREE-FOLD PROBLEM

It follows that the prevention of such lesions requires the solution of three problems which are all inter-dependent, viz :

- (1) Keeping the foot warm.
- (2) Keeping the foot dry.
- (3) Maintaining the vascular tone of and blood flow through the foot.

All attempts to solve the problem must take account of all three.

### CAUSATION OF COLD FEET

Feet may become cold from indirect causes, either because they are wet or because the blood flow is decreased. Direct causes are, however, a general chilling of the whole body such as occurs at temperatures of 23° F. and below, in which the temperature of the blood falls well below the normal range, and by loss of heat from the foot itself. This is usually by conduction either to the surrounding air or, more important, through the sole of the boot to the ground. Mention should be made here of the "windchill factor." The rate of loss of heat being proportional to the difference in temperature between the warm object and its environment, it follows that if the air in immediate contact with the object is moving, it has no chance to warm up and so reduce the rate of loss of heat. The effect of this may be calculated, and as an example it may be said that the rate of cooling at a temperature of 24° F. with a 40 m.p.h. wind is the same as that of -11° F. with a 5 m.p.h. wind. Heat is also lost from the skin by the evaporation of sweat, and this loss has to be accepted where it is undesirable that sweat be retained.

### CAUSATION OF WET FEET

Feet may become wet because water leaks in through or over the tops of the boot, or because the foot sweats. Whether it be the "insensible perspiration," leaving the skin as water vapour, or true sweat, fluid invariably accumulates. The amount of sweat produced can be surprisingly large; it is always greater in forward troops, doubtless being of psychosomatic origin, and is to be expected. Foot infections also increase the amount of sweat produced, the chief offender being, of course, chronic tinea pedis.

### CAUSATION OF POOR VASCULAR TONE AND BLOOD FLOW

The first and most important cause of decreased blood flow in the foot is the peripheral vasoconstriction which occurs automatically as a defence reaction against cold. The skin blanches generally and the blood flow to the extremities decreases in order to reduce the rate of heat loss from the skin surface. Reduction of blood flow to the feet may be still further achieved by inadequate protection of the legs from cold. Dehydration also plays a part in a similar way

by reducing total body fluids, and is more common than might be supposed in cold weather, when cold water is unpalatable and the amount of hot drinks available may well be limited. Local factors are prolonged dependency and immobility of the foot ; dependency tends to produce stasis, and failure to use the muscles of the feet and calves deprives the veins of the assistance thus usually given to them in returning blood to the heart. Hypoxia of the tissues of the foot follows from the reduced flow.

#### METHODS OF TACKLING THE PROBLEM

In a theatre of war in cold climates the threefold problem may only be approached from three aspects :

- (1) Modification of the environment.
- (2) Provision of adequate clothing.
- (3) Arranging the activities of the individual.

Each of these must be considered from each of the three aspects of the problem.

#### ENVIRONMENT

It seems trite and unnecessary to say that as much as possible of the force should live and work under reasonably warm conditions, but the point has to be emphasized for planning purposes, so that the requisite numbers of heating appliances and tents may be provided. Emphasis is placed on tentage, because cold countries are not as a rule densely populated, and buildings may well be few. The requirement for heating appliances in Korea has largely been met by the American tent stove, which is an excellent piece of equipment, burning petrol, kerosene or diesel, two such stoves being quite adequate to heat a tent capable of sleeping 18 men comfortably in the conditions experienced.

In addition, several improvised varieties of heater, perfectly safe and burning petrol or diesel, have been designed and made locally from scrap materials.

Provided that the necessary equipment is available or can be procured or improvised, the provision of warm working and living conditions presents no difficulty as far forward as Brigade or even sometimes Battalion Headquarters ; even those whose day-time work is out of doors, *e.g.*, drivers, sappers, pioneers, linesmen, recovery troops, etc., up to this level can have suitable accommodation, temporary or permanent, to return to at the end of the day's or night's work. This applies also to artillery and to armoured units when out of contact with the enemy. The problem is much more difficult, however, for infantry in contact, occupying positions which are in full view of the enemy, where the smoke from a stove of any sort may give the position away completely. The solution in this case is to provide a "warmery" on a company or preferably a platoon level, a little way back and out of sight of the enemy, to which sub-units are regularly rotated for a "warm up" lasting a half to one hour at least once daily. This allows the whole body to warm up, permits peripheral vasodilatation to occur and gives a complete period of rest, relaxation and recuperation. It allows the removal of boots, changing of socks and insoles, the writing of

letters, and also permits the brain to recover and start functioning again ; for one of the side effects of cold is to reduce thought to one track and one track only—how to keep warm.

The foregoing applies to static warfare, such as we have seen in Korea during the winter of 1951-2. During the mobile warfare of 1950-1, much of the foregoing was not possible, but every attempt was made in the Commonwealth Forces to produce something resembling it. Infantry fighting long retiring engagements and never getting a chance to stop and warm up suffered the most, and the incidence of cold injuries was high in such units.

#### CLOTHING

Reference may be made here to certain well-known general principles in the maintenance of thermal equilibrium of the body and the design of winter clothing. Maintenance of thermal equilibrium demands that the rate of generation of heat by the body shall equal the rate of loss. Production of heat can only be increased by giving a high calorie diet and by muscular exercise. The rate of heat loss can, however, be controlled to a considerable degree by provision of adequate clothing. Heat loss from skin surface occurs by radiation to a small extent, but chiefly by conduction to the air and by the evaporation of sweat. The well-known solution is to surround the body with layers of air, trapped but circulating, which serves the several purposes of good insulation, maintaining a constant temperature of the air next the skin, and allowing gradual evaporation of sweat at a steady rate, so that the rate of heat loss remains more or less constant. This system also has sufficient "elasticity" to accommodate an increase in heat production, *e.g.*, by violent muscular exercise, and still keep the temperature of air next the skin about the same. Consequently British winter clothing consists of the string (Brinje) open-work vest next the skin, covered by a loose flannel shirt and a heavy loose knitted woollen pullover. In the winter of 1950-1 a battledress jacket was worn over the pullover, and the final layer was a windproof smock. The present issue for 1951-2 is a windproof jacket closing with a zip fastener in front, over which may be worn the middle parka with a wool pile lining and windproof outer cover. Similarly the legs are covered with long loose drawers, pyjama type, heavy "trousers inner fleece," with windproof trousers as the outer layer. (In 1950-1 the equivalent was battledress trousers with windproof over-trousers.)

Whatever the type of clothing, the outer layer is a close-woven material, windproof to reduce the wind-chill factor and to enclose the layers of air. It may be partially impervious to water but must not be impervious to water vapour, and consequently not waterproof, otherwise water vapour from the so-called insensible perspiration will condense on the inside and freeze, as will liquid sweat produced during muscular exercise.

The main difficulty in designing such clothing always lies in the disposal of sweat, and the method described above allows ventilation, variable at will by the individual by opening the neck of his garments and changing the position of his zip fastener.

A somewhat different approach to the problem has been made in the American Vapour Barrier suit. This is of polyvinyl chloride, a plastic in a foam structure, about three-quarters of an inch thick, worn next the skin as the only garment and separated from it by numerous small hummocks on the inside of the suit. Sweat is retained and consequently little heat is lost by its evaporation ; the insulation provided by the waterproof and consequently windproof plastic is adequate to ensure that the sweat does not freeze. This method shows considerable promise for the future provided that continuous exposure of the skin to 100 per cent. humidity does not give rise to trouble.

Whatever method is used, however, the important effect is to maintain thermal equilibrium and prevent or reduce the peripheral vasoconstriction of the extremities.

The problem of clothing the feet, however, is not quite so straightforward. Similar principles to those of conventional winter clothing can be applied in dry-cold conditions (*i.e.*, temperatures persistently below freezing point at all times of the day, when the ground is either always frozen or always covered with dry snow) by the use of the mukluk. This calf-length boot has a rubber sole and a close-woven canvas upper ; it is worn with a thick felt insole separated from the sole by seven layers of fine plastic (saran) mesh. Two pairs of heavy wool socks and one of duffle socks (same material as duffle coats) are worn. The most important layer is the saran mesh, which maintains an insulating layer of warm air between the sole and the ground and permits evaporation of sweat.

Foot-gear in regular use in Korea, however, has to be designed for wet-cold, since however cold the nights, there is on most days a midday thaw, and the late autumn and early spring are *par excellence* wet-cold conditions. The problem is to keep mud and water out of the boot as well as keeping the foot warm. One attempt at a solution is a rubber overboot, worn over an ordinary light leather marching boot (U.S. description "high shoe"), *e.g.*, the U.K. type ammunition boot or the U.S. type "combat boot." The disadvantages are, however, clear. Although there is no leakage of water into the boot, and there is a layer of enclosed air between the rubber boot and the marching boot, nevertheless sweat accumulates and pools in the sole of the marching boot if the two types of boot are worn together constantly. Further, even two pairs of socks worn with the marching boot give inadequate insulation. The position is improved if the overboots are removed regularly whenever the soldier is in a warm place, or when marching over dry areas, so that sweat can evaporate from the feet, but the disadvantages of carrying two pairs of boots are apparent. This type of footwear was used with some success in the winter of 1950-1 by one Commonwealth battalion, but cases of cold injury did occur.

The U.S. Army shoepac is another attempted solution. The sole and lower part of the upper are made of thick rubber ; the upper part is of leather closely stretched to the rubber, the tongue being attached at both sides all the way up, and the whole lacing up in front. It is a calf-length boot, completely waterproof, and is worn with a half-inch felt insole and three pairs of heavy woollen

socks. The advantages are that no water enters the boot except over the top, and that when first put on with dry socks and insoles it is warm and comfortable, and being flexible, it allows toe movement and consequent increased blood flow in the foot. The disadvantage is that disposal of the sweat is impossible; experience has shown that with this type of boot socks and insoles become appreciably wet in half a day and require changing twice daily.

In temperatures below 10° F. this sweat will freeze on the inside of the boot, and if there is no opportunity to change insoles and socks within twelve hours, the foot is in contact with a wet woollen material little above freezing point—the ideal condition for producing trench foot. Under wet-cold conditions above 32° F. the foot, being warmer, sweats even more; a similar state of affairs exists at a higher temperature, and a condition intermediate between a trench foot and a hyperidrosis occurs. It is such a specific entity that it has been given the local title of “shoepac foot.” Troops wearing this boot suffered heavy casualties from cold during the winter of 1950-1, during periods of heavy fighting and continuous movement where they had little or no opportunity to change their socks and insoles.

Two types of leather boot have been designed as compromises. The Boot F.P. (Finnish Pattern) is in many ways an excellent boot. It is made of thicker leather than the ammunition boot, has a leather sole half an inch thick, heavily studded, and is worn with a quarter-inch thick felt insole mounted on a thin cork base and two pairs of socks. This boot was worn exclusively by one Brigade Group in Korea in the winter of 1950-1; it is true that a number had deteriorated during storage, the leather cracked and the stitching rotted, but those which were in good condition were waterproof enough but not completely impervious to water vapour. The insole became appreciably damp after twelve to eighteen hours and the socks were similarly affected. An issue of two pairs of insoles was made with each boot, which allowed one pair of insoles to be constantly drying. Appreciable numbers of cold injuries did in fact occur, on one occasion in one battalion in which there was a 100 per cent. stand-to on two successive nights and a 70 per cent. stand-to on the third, no opportunity being given to the men to change their socks or insoles. The disadvantage of this type of boot is that it does not in fact give sufficient insulation from the environment, but it is certainly adequate in rear areas and even in forward areas if the socks and insoles can be changed daily.

The new U.K. boot in use in Korea (Boot C.W.W.—“cold-wet weather”) is a leather boot modified from the design of the ammunition boot. The uppers are of similar type of leather, waterproof enough but not impervious to water vapour, with a leather rolled “hem” round the ankle to fit snugly. The sole is a little more than half an inch thick; the lower layer is thick cleated composition rubber and there is a layer of plastic between the two layers of leather. The various layers of the sole with which the upper makes a watertight junction are held together by screws. The toe is blocked to allow free movement of the toes. The insole is a simple arrangement of seven layers of fine plastic mesh (saran) just less than a quarter of an inch thick. One pair of worsted socks and

one pair of heavy woollen socks are worn. Apart from certain minor defects in the manufacture of the sole, this boot has proved excellent. Perspiration from the foot does tend to collect on the sole of the boot, but this little pool is separated from the sole of the sock by the layers of air enclosed in the meshes of the saran insole and consequently, though the sole of the boot may be wet and even frozen, the sock and foot are dry. On theoretical grounds there are obvious advantages ; the combination of a good leather marching boot with a waterproof sole from which the foot is separated by a layer of trapped air in the meshes of the saran insole satisfies most of the requirements. The number of cases of cold injury in troops wearing this boot has been negligible in comparison with other types of footwear, and it has been generally found to be warm, comfortable and practical. There is no doubt that it is superior to any other cold weather foot-gear in current use in Korea.

A new and totally different principle in footwear design has been developed by the U.S. Army—the vapour barrier boot—similar in principle to, and intended to be worn with, the vapour barrier suit. The aim is purely to ensure that the foot is warm ; sweat is retained, thereby reducing loss of heat by evaporation. The boot is made of rubber and lined with rubber ; the insulating material lies between the two waterproof layers and only one pair of socks is worn. The principle is that the insulating material never gets wet or freezes and consequently the foot remains warm. Sweat collects within the boot, does not escape and on account of the warmth of the foot does not freeze. The atmosphere surrounding the foot remains constantly at 100 per cent. humidity, and under these conditions a water equilibrium on the skin surface is attained, fluid being simultaneously excreted and re-absorbed. In practice this boot has in U.S. troops already shown itself superior to the shoepac, as judged by the incidence of cold injuries ; the long-term effect of 100 per cent. humidity on the foot at body temperature remains to be seen.

#### ACTIVITIES OF THE INDIVIDUAL

Military operations are undoubtedly the biggest single factor influencing the incidence of cold injuries. Heavy fighting, much movement of units and high intensity of work have invariably produced a marked rise in the incidence. This is true even if the lesions sustained after wounding are excluded, and has been proved on many occasions by the U.S. Army during the two winters in Korea. A clue to the reason is given by the experience of a U.K. battalion, already mentioned, in the winter of 1950-1 wearing the Boot F.P. The battalion sustained forty-eight hours on 100 per cent. stand-to followed by twenty-four hours on 70 per cent. stand-to and had no opportunity to get warm, to remove their boots or to change their socks or insoles. This battalion had a week or so previously lost the equivalent of a company in battle, including the Second-in-Command ; the Commanding Officer had been evacuated sick, and they were in a very tense state. Operational discipline was strict and to this everything else was subordinated. Their role prior to the battle had been in reserve, or carrying out blocking operations, usually in hilly country in places where a

resourceful man had the time, materials and opportunity to construct himself a shelter; the position they held after the battle was flat with little cover and there was little tentage and no buildings. Night temperatures were not much below 12° F., but there was a considerable amount of sleet at times. They dug little more than slit trenches and in these they remained. The situation did not improve until a "warmery" was set up by the supporting field ambulance—a heated tent in which each man spent, in rotation, one hour, removed his boots, massaged and dried his feet, changed his socks and dried his insoles. After this the battalion constructed its own "warmeries" and the flow of cases of cold injury was reduced to a trickle.

Other U.K. battalions similarly dressed but more fortunately placed with respect to buildings and availability of material had been able to construct "warmeries," and their incidence of cases was very much less. At this time also a brigade order laid down that every man's feet would be inspected daily by an officer, and the situation came under control.

This incident confirms the view that lack of foot care is the most important factor involved. It is clear from what has been said before that the problems reduce to those of disposing of the sweat and maintaining the circulation of the feet.

Obviously the basic step is to reduce the amount of sweat produced. Hyperidrosis is all too common and its treatment difficult. The only treatment of any avail is the use of formaldehyde as a 3 per cent. solution in a footbath twice a day, or as a 20 per cent. paint on the sole, not more often than fortnightly. The latter requires careful supervision and the foot must be dry before it is painted. This the medical officer can do, and it is no great hardship to inspect all the feet of a unit at a periodic F.F.I. and bring under treatment the infected and hyperidrotic.

However, the feet have to be maintained in good condition, and since cold injuries can develop rapidly, commonly over a period of twenty-four hours, it is necessary for daily attention to be given to ensure daily removal of surplus sweat and restoration of the circulation. This was for the winter of 1951-2 in the Commonwealth Division taught as a daily drill under the supervision of an officer as follows:

Each man, once a day, preferably in the late afternoon or evening, is brought into a warm place and removes his boots and socks.

The inspecting officer asks him if he has any foot trouble, checks his boots, socks and insoles and examines his feet. Any deterioration in the condition of the feet is noticed and the man referred to the M.O.

The man then washes his feet in warm water, dries them carefully, powders them and puts on a clean dry pair (or two pairs) of socks. Insoles are also changed.

It is quite certain that a daily drill of this nature will prevent the vast majority of cold injuries, provided that the clothing and footwear are adequate. It is equally certain that failure to do so will produce cold injuries, as was demonstrated in one U.K. battalion in the winter of 1951-2.

It is impossible for the medical officer to carry out or supervise the drill in detail ; it cannot be entrusted to the individual soldier or even N.C.O., who has many other things to think about, and it must therefore be the responsibility of the officers of the unit to ensure that it is in fact carried out. Not only is the drill necessary to ensure care of the feet, but also to be certain that the man is in fact wearing the right footwear. The four cases sustained in the battalion quoted above all occurred in one platoon in which the drill had not been carried out ; and although the C.W.W. boot was in regular issue in that Battalion, one man wore a U.S. shoepac without insole and another a C.W.W. boot with felt insoles which was too tight for him. The other two wore C.W.W. boots, but none had changed their socks for two to three weeks.

It may well be argued that the drill cannot always be carried out in periods of heavy fighting or considerable movement, but this is not so. It may be necessary to forgo the washing, but there are very few occasions or situations in which a man cannot take ten minutes off once in the course of twenty-four hours and, one foot at a time, take off his boots, powder and massage his feet and put on a clean pair of socks. Much has been written of the "buddy" system, and there is no doubt that working in pairs men can without any difficulty assist each other in the care of the feet. It is particularly important to take such action after a day of marching or climbing, during which time the feet have sweated more than usual, before either being carried elsewhere in a vehicle or mounting guard, manning an F.D.L. or holding a position just taken. There is, as we have seen, no better way of inducing a cold injury than to stand or sit still with moist feet, and the drill should be carried out routinely in every case.

If a C.O. decides that the tactical situation does not permit removal of boots, then he must accept the inevitable casualties which follow, just as in advancing over a minefield or a mustard gas contaminated area.

In addition to the daily drill, there are certain things men can be taught to do to maintain the circulation in their feet, and these lie chiefly in continuously exercising them when standing still. Ankle rolling and toe wriggling within the boots are the most important exercises and men soon learn their value in keeping the feet warm once they have grasped the idea. Exercise in general is valuable in increasing the output of heat of the whole body. •

Activities of the man include also his consumption of food, and there is no doubt that a high calorie diet is essential to ensure that the body generates sufficient heat to prevent peripheral vasoconstriction. A minimum of 5,000 calories is the accepted figure and the appetite in cold weather justifies this. It seems probable also that the requirement for vitamin C is increased, and while no definite figure has yet been decided it appears to be not less than 50 mg. daily and possibly as much as 100 mg.

#### SUMMARY AND CONCLUSIONS

It is not the writer's place to discuss the details of administration necessary to ensure that proper precautions against cold injuries are taken. The allocation



of responsibility for the various measures is, however, important. The administrative staff at the planning stage must consider the problems of shelter, heating appliances, adequate food and clothing. In particular enough socks and laundry facilities must be provided. It is manifestly impossible for a man to wash his own socks in extreme cold. The number of pairs of socks per man depends on the speed of laundry turn-round. With a twenty-four-hour turn-round the minimum number is five pairs per man in order to ensure a clean pair daily for issue. Sock washing should not be made a unit responsibility, although most quartermasters can and do run their own laundries.

The General Staff should be responsible for training all ranks in personal precautions.

The responsibility of the Medical Services is to ensure that all feet are in good condition by treatment and by rejection of the unfit. But, whatever equipment or training is provided, cold injuries will still occur unless the man himself ensures that he does not accumulate sweat in his boot and that he keeps his circulation going. The responsibility for ensuring that this is done must lie with the unit.

In the Commonwealth Division this was so ; in the majority of cases where cold injuries did occur (and there were few in comparison with other members of the U.N.) the men had in some way escaped the daily foot inspection drill. It came to be felt that to have a case of cold injury was a slur on the unit, and there is no doubt that the fostering of this attitude played a very great part in the prevention of such casualties. The policy for any future campaign in a cold climate should be that, no matter what equipment is provided, it is the responsibility of the unit to ensure that every man's feet do in fact receive daily attention. Under these circumstances cold injuries should never present any problem, and cold weather becomes merely another health hazard overcome by competent unit administration and discipline.

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# THE ROLE OF THE MUSCLES IN THE ÆTIOLOGY OF HEADACHE

BY

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PERSISTENT or recurrent headache in the absence of demonstrable organic disease is one of the commonest clinical problems and an important cause of disability. Unfortunately there is a tendency among doctors to fight shy of objective clinical analysis of headaches, so that diagnoses are apt to be nebulous and treatment a combination of placebos and platitudes. This is the more regrettable because such analysis is not difficult and is often therapeutically rewarding. However, I do not intend in this article to expound the systematic diagnosis and treatment of headaches, but simply to draw attention to a common ætiological factor which is often overlooked: that is, pain in the muscles.

Lewis (1942) states that muscles may become painful and tender as a result of prolonged contraction, and Wolff (1948), quoting his own and other workers' observations, shows that pain of this nature may arise in any of the groups of muscles about the head and neck, including the nuchal muscles, the scalp muscles, the muscles of mastication, and even the pharyngeal and ocular muscles. Every doctor is familiar with the sustained spasm of muscles in the region of an injured joint or over an inflamed viscus, but many forget that the same reflex spasm may occur as a result of painful lesions of the head and neck, and that this spasm may in itself give rise to further pain in due course. Similarly the general increase in muscular tone that accompanies emotional tension, anxiety and apprehension is common knowledge, but the significance of this mechanism as a cause of headache tends to be forgotten.

Prolonged muscular contraction about the head and neck may result from a great many causes which may be classified on a clinical basis as follows :

- (1) Reflex spasm secondary to any painful lesion in the vicinity, *e.g.*, migraine or other headache, sinusitis, pharyngitis, otalgia, ocular disease, adenitis, arteritis, lesions of mouth, teeth, jaws, skull, cervical spine, etc.
- (2) Disorders of the muscle itself, *e.g.*, fibrositis, sprains, bruises, scars, etc.
- (3) Physiological disturbances of muscular action and balance, *e.g.*, faulty or unaccustomed posture, fatigue.
- (4) Neurological conditions, *e.g.*, neuritis, neuralgia, pressure on nerves, many intracranial conditions (*e.g.*, meningitis, posterior fossa tumour), tetanus, etc., the majority of little importance for the present purpose.
- (5) Emotional tension.

This list is not, of course, exhaustive, but it includes the causes of clinical importance.

It is important to be able to recognize the presence of a significant muscular component in a headache because it is usually amenable to simple therapy, in contrast to some of the other factors involved. Let us therefore, by way of illustration, consider some representative case-histories.

*Case 1.*—Lieutenant-Colonel, retired, U.S. Army, aged 58. This heavily-built man had pain and limitation of movement in the cervical and lumbar spine as a result of fractures of vertebræ sustained several years previously. While in hospital for review of these disabilities he remarked that in addition to backache, to which he was accustomed, he had recently started to have severe occipito-vertical headaches. His blood-pressure was 160/100, and he had been told by his doctor at home that his headaches were due to hypertension; this information had made him mildly neurotic about his new symptom.

Physical examination revealed marked spasm of the upper nuchal muscles and the occipitalis, and radiography showed that there was gross osteoarthritis of the upper half of the cervical spine, in the region of an old fracture. Though his blood-pressure was moderately raised, his heart, peripheral vasculature, optic fundi and urine were all normal. His headaches were therefore attributed to muscle spasm secondary to the painful spinal condition; it is possible, of course, that direct pressure on nerves may have played a part. At all events, spasm and headache were relieved by local heat treatment, but more lasting benefit would have necessitated extensive orthopædic procedures which the patient did not wish to submit to.

*Comment:* This is an example of reflex spasm in the vicinity of a painful lesion. Although treatment was not very satisfactory, the patient was much relieved to learn that his new symptom was merely part of his old trouble and not hypertensive in origin, and his iatrogenic neurosis was nipped in the bud.

*Case 2.*—Captain, W.R.A.C., aged 28. This patient complained of headache for several months. It started in the temples as a dull throbbing, spread back to the occiput, down the neck and often into the shoulders. It was worst when she was worried or working especially hard; recently the radiation to the back of the head had become more pronounced and tended to persist even when the temporal throbbing died away. She was otherwise well, but admitted that the headache had begun to impair her efficiency at work and her enjoyment of life generally.

On examination she was athletic, highly intelligent and a little tense. Her blood-pressure was 115/70 and she showed no evidence of organic disease. At the time of first examination she had a moderately severe headache, partly relieved by manual obliteration of the temporal pulses, leaving a duller pain extending to the occiput and down the neck. There was considerable limitation of movement of the neck by muscle spasm, and innumerable tender nodules in the neck muscles, the trapezii, deltoids, and elsewhere. On a subsequent visit,

when she was without headache, a deep subcutaneous injection of 1 mg. of histamine acid phosphate reproduced her "usual" headache perfectly.

On further questioning she admitted that she had been subject to headaches most of her life, though they had never interfered with her activities. She had also had a good deal of muscular rheumatism, especially in the shoulders.

The diagnosis made was (1) vascular headache brought on by emotional stress, and (2) painful muscular spasm secondary to the foregoing, and aggravated by pre-existing fibrositis. Histamine "desensitization" and various other procedures had little effect on the vascular headache, but the muscular component responded excellently to physiotherapy. The final outcome was that she continued to have throbbing temporal headaches when under stress, but these responded fairly well to aspirin and caused her little concern: the muscular component went and did not return. She remarked that her neck must have been stiff for months, but she did not realize it until treatment restored normal mobility.

**Comment:** This is an example of the two-component headache, and also of the importance of fibrositis in this type of headache. It shows that even when the ultimate cause of a headache resists treatment a useful degree of improvement can often be achieved by dealing with the more amenable muscular component.

**Case 3.**—Officer candidate, U.S. Infantry, aged 21. This athletic man, during physical training at an Officer Candidate School, was doing a series of leaps into the air from a crouching position; after some seventy of these he experienced sudden excruciating pain in the occiput, radiating over the vertex and down his neck. He felt sick, weak, and blinded by pain, and fell out of the class. However, he was due to be commissioned in a week or two, and being of a resolute character he somehow made light of his pain and after a rest carried on with his training. The pain remained very severe, though it eased a little when he lay down; nevertheless, in three days he was so worn out by pain that he had to see the Medical Officer, who sent him to hospital with a diagnosis of subarachnoid hæmorrhage.

On examination he was an intelligent and unemotional man of excellent physique, who looked tired and drawn and held his head stiffly. He had no fever and his blood-pressure was 125/75. The nuchal muscles were in tight spasm, especially on the left, and there was an acutely tender point deep in the muscle just to the left of the third cervical spine; pressure here caused agonizing and sickening headache which radiated in all directions and made him feel faint. There was, of course, marked stiffness of the neck, but none of the lumbar spine and Kernig's sign was negative. There were no abnormal findings in the central nervous or other systems, and X-rays of the skull and neck showed no bony abnormalities.

His symptoms and signs pointed to a tear in the nuchal muscles, and treatment consisted of rest in bed, local heat, and analgesics. His symptoms improved promptly, and in three weeks he was able to return to full duty.

**Comment:** This form of physical training appears to be popular in the

American Army, and not unnaturally produces a good deal of skeletal trauma, especially tears of various extensor muscles. Nuchal sprains from other causes can give rise to a clinical picture similar to the foregoing, and are by no means rare as a result of falling over backwards and other misadventures in the course of parachuting, military training and Rugby football.

*Case 4.*—Wife of Sergeant, U.S. Infantry, aged 30. This lady had suffered from severe headaches since the age of 20. The pain started at the base of the skull and spread in all directions, into the face as well as the temples, vertex and neck. Though there were no obvious precipitating factors, she noticed that she had more and worse headaches in some localities than in others: she had been relatively free from them in Colorado, but since coming to Georgia they had become increasingly frequent and severe. She had been treated by many doctors all over the world, and five years previously had attended a well-known headache clinic in New York, where she had been told she had migraine and treated accordingly; however, at no time had she obtained significant relief from ergot, caffeine, nicotinamide, histamine, hormones or barbiturates, though compound codeine tablets temporarily allayed the pain. Despite her wide and unsuccessful patronage of the medical profession, she was not at all neurotic about her complaint.

On further questioning she admitted that fibrositis was "in the family," and that she often had bouts of muscular pain and stiffness coinciding with her headaches. Physical examination revealed no abnormality beyond innumerable tender nodules in the muscles of the head, neck, shoulders and back. A diagnosis of fibrositic headache was made and physiotherapy and salicylates prescribed. The headaches improved and vanished after two weeks' treatment; they returned a few months later and were again dispelled by the same treatment.

*Comment:* This is an example of severe headache due to fibrositis alone. As Cyriax (1938) points out, such headaches often persist for years with little change in pattern or severity. It must be noted that fibrositis can rarely be eradicated though it is usually easily alleviated, so that treatment may have to be repeated from time to time.

It should perhaps be explained that the last patient's aggravation of symptoms coincided with her arrival in a part of Georgia which is low-lying and damp, with an evil reputation for evoking rheumatic tendencies.

*Case 5.*—Second-Lieutenant, U.S. Infantry, aged 22. This officer, who had recently transferred from regimental to staff duties, complained of almost daily occipital and nuchal headache, increasing in intensity for two months. It came on in the course of the morning and persisted until he went to bed; sometimes it was associated with a vague stiffness of the shoulders and upper part of the back. He seldom had it on days when he did not go to work. His work consisted of studying and marking large maps laid out on drawing-boards, over which he had to bend for hours at a time.

He was otherwise fit. His Medical Officer attributed the headaches to the strain of his staff duties, but the officer himself maintained that he liked his job, was competent at it, and not at all worried about anything except the headaches.

On examination he was in all respects normal, but there was spasm of the nuchal muscles and tender nodules in them and along the upper borders of the trapezii. The diagnosis was clearly headache due to postural muscle-strain. He was given a short course of physiotherapy to disperse the nodules and spasm, and advised to rearrange his map-boards so that he could work at them in comfort. His headaches went at once and did not return.

Comment : The diagnosis was self-evident once a careful history had been taken. This is a common type of headache in those who from habit or necessity sit hunched over their work, such as typists, draughtsmen, accountants, watch-repairers, and even pathologists.

Muscular headaches due to emotional tension are a heterogeneous group. Moench (1951) regards them largely as a legacy from our quadrupedal ancestors, who at times of stress and danger raised their heads and pricked their ears the better to employ their organs of special sense. In addition, it is useful to recall the clenched teeth and heavy frown of apprehension and determination.

Case 6.—Corporal, U.S. Infantry, aged 23. This highly-strung man complained of severe bitemporal headaches almost daily for several weeks. He had been subject to headaches at times of stress most of his life, and had often missed days at school because of them : he admitted that he had often used them consciously to dodge unpleasant duties. There was a history of a nervous breakdown before an important examination at college. He had a number of personal worries and for some weeks had been sleeping badly.

On examination he was nervous, fidgety, and bit his nails, but there was no evidence of organic disease. A diagnosis of anxiety neurosis was made, and he was treated for this in co-operation with a psychiatrist, but little progress was made and his headache persisted.

On re-examining him a little later I was struck by his tightly clenched teeth and iron-hard masseter and temporal muscles. He acknowledged that he usually clenched his teeth when anxious or apprehensive, and thought that it might have become a permanent habit. By encouragement and instruction in deliberate relaxation the habit was gradually overcome and his headaches improved greatly *pari passu*, though the underlying nervous tension remained unaltered.

Comment : In this case emotional muscle spasm seems to have been the only cause of headache, and the muscle groups affected were unusual. An impacted wisdom tooth or arthritis of the temporo-mandibular joint can cause temporal headache by a similar spasm of the muscles of mastication.

Case 7.—Captain, Royal Signals, aged 32. In the middle of the Egyptian summer this officer, who had sandy hair, a fair complexion and a worrying disposition, complained of frequent frontal headaches. These were worst when he was out in the sun, but also occurred at other times. The pain always

commenced just above the bridge of the nose, spread gradually over the forehead, and at length involved the whole head. He said that he had always been sensitive to the sun, but had nevertheless spent many years in tropical countries without noteworthy headaches or other symptoms until recently. He admitted to much worrying over his work and private financial affairs.

On examination, the most impressive feature was the intense frown which contorted his whole forehead and even the upper part of his face. I asked him if he always frowned so heavily, and he replied somewhat sheepishly that only a few days previously his wife had taken him to task because he was never without a frown of late. The only significant physical abnormality was a mild chronic conjunctivitis.

The headaches appeared to be due to the intense and prolonged contraction of the procerus, frontalis, orbiculares and other neighbouring muscles, the frowning itself being partly emotional in origin and partly an attempt to protect his sensitive eyes. The habit was gradually broken by the mere fact of drawing his attention to it, by making him wear efficient sun-glasses and a peaked cap instead of a beret, and by helping him to adjust his attitude to his personal difficulties. His headaches became progressively less frequent and ceased to distress him.

Comment: The last case demonstrates how physical and psychological factors may be interwoven and reinforce one another.

*Case 8.*—Sergeant, U.S. Army, aged 38. This N.C.O., a temperamental cook of continental extraction, was an active, muscular man who claimed never to have had a day's illness in many years' service all over the world. In the course of a wordy argument with another N.C.O., while brandishing a saucepan the better to emphasize a point, he was seized with severe pain in the back of the head, whereupon he became hysterical and incoherent, rolling on the ground in agony. He was admitted to hospital.

When I saw him a few hours later he was quiet and rational though very nervous, and complained of severe left-sided occipital headache and stiffness of the neck. The only physical abnormality was a large tender nodule in the muscle one inch to the left of the spine of the axis; pressure upon it caused severe aggravation of the headache. The nodule was forthwith infiltrated with 1 per cent. procaine solution, which caused transient increase in pain followed by relief. An hour later he asked to be discharged from hospital as he was now quite well. The pain did not return.

Comment: Despite his emotional disturbance, I believe that the real cause of his pain was an organic disorder of his nuchal muscles, possibly a localized area of cramp. Prolapse of a high cervical disc can give rise to a clinical picture like this, but lasting relief by procaine infiltration is against this diagnosis here.

#### DISCUSSION

Many further examples could be quoted, but the foregoing case-histories suffice to illustrate the more important clinical pictures met with in headache

of muscular origin. The important part played by that obscure but ubiquitous entity known as fibrositis is obvious: sometimes it is already there as a predisposing factor, sometimes it appears only after prolonged muscular contraction and seems to be secondary to it.

It is important to emphasize that in all the examples quoted the muscular component was at least as prominent as any other that might have been present, and it is in such cases that simple therapy of the muscular pain may be expected to bring much relief; but when the muscular pain is secondary and subordinate to pain of some other origin (for instance, muscle spasm secondary to severe migraine) therapeutic success depends almost entirely upon conquest of the latter. A large proportion of headaches that last for more than a few hours acquire a secondary muscular component.

Psychogenic headaches are usually of mixed pathogenesis, partly vascular, partly muscular, and perhaps partly due to psychological conversion mechanisms. Worry about the headache, or about the loss of working efficiency that it produces, very often increases and perpetuates the headache itself: sympathetic but authoritative reassurance will often break the vicious circle and send the patient on his way smiling and confident.

The diagnosis of muscular headache depends upon the physician's stock-in-trade: careful history-taking, thorough physical examination, and an ability to think of the patient as a person and not just a lot of "systems" in fortuitous juxtaposition. It should not be necessary to point out that the head and neck should not be omitted from the physical examination, yet patients not infrequently state that this has not been done by their previous doctors.

Some mention must be made of intracranial tumours, because the suspicion that he may have one often causes the headache patient to become neurotic, and the possibility that he might miss one causes many a doctor to lose his judgment and sense of proportion. Intracranial expanding lesions are commonly accompanied by headache, of course, and some (especially those in the posterior cranial fossa) may directly or indirectly cause muscle spasm; but it behoves the physician to preserve a sense of proportion and remember that headaches are exceedingly common, whilst intracranial tumours are rather rare.

Treatment is largely common sense. Where practicable the cause should be eradicated, but often this is impracticable if not actually impossible. Emotional factors are very common, and by and large we cannot change a patient's obsessional or worrying temperament or solve all his personal problems, though we can do much to help him to acquire the right attitude towards these things. Instruction in relaxation is important, for many tense persons do not know how to relax, even in sleep. Local application of heat, massage, manipulation and active exercises help to relieve muscle spasm and disperse fibrositic nodules, and an intelligent patient may be taught to apply these simple remedies himself. Injections of procaine into painful spots are sometimes effective in breaking a vicious circle of pain—spasm—pain. Mild sedation by barbiturates and the like helps relaxation, and specific muscle relaxants such as myanesin have also been used for this purpose. Friedman



(1951) recommends vasodilators such as nicotinic acid in large doses for the relief of muscle spasm and fibrositis. Finally, such time-honoured remedies as aspirin and compound codeine tablets are not to be despised.

Too often the problem of headache is approached by doctors in a pessimistic and defeatist spirit: too often the patient with persistent headache is regarded as an incubus to be passed dexterously to an unwary colleague. Nevertheless, as I have attempted to show, there is much clinical interest in this field, and much satisfaction to be gained from the results of treatment; in the common variety of headache discussed, moreover, diagnosis depends upon no more than ordinary clinical ability and therapy upon only the simplest of procedures. The whole subject is of great practical importance and merits more attention than it at present receives. For those who may wish to pursue it further Moench (1951) gives a succinct and balanced account.

#### SUMMARY

1. Muscles about the head and neck, as elsewhere, can become painful and tender as a result of prolonged contraction. This may occur clinically through a variety of common causes, giving rise to headache.

2. Detailed case-histories are quoted illustrating the more important features of muscular headache.

3. The general principles of diagnosis and treatment of muscular headaches are briefly discussed.

#### ACKNOWLEDGMENTS

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## THE CHARNLEY WALKING CALIPER

BY

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THIS weight-relieving caliper was designed by Charnley during the war, and was accepted by the War Office as the standard Army caliper for short-term use in adults, for the treatment of fractures of the femur that had reached that stage of union which was not yet considered solid enough for unprotected weight bearing.

It is essentially a temporary caliper, and as such has valuable advantages. It can be mass-produced. It is cheap to make. It can be fitted in half an hour from stock, so that a patient can have his plaster removed and be fitted directly into a caliper. The ring can be correctly fitted to the root of the limb and is then comfortable. The components of the caliper can be used again and again on different patients. It eliminates the inevitable delay when ordering a caliper from a proprietary source.

The use of calipers in the Army in fracture work permits of early ambulation, and frees hospital beds to allow the patient to proceed to Convalescent Depot where periodic joint movement out of the caliper can be carried out; thus rehabilitation, both local and general, can be carried out while in a caliper at these centres.

Patients evacuated from Commands abroad are frequently seen fitted with a caliper of a proprietary type made to measure from local resources, to fit individual patients, who shortly after arrival in this country are able to discard this caliper, which can now not be used again. If, instead, the patient has been fitted from stock with a Charnley Walking Caliper, these parts could be taken into use in this country. Further, there is a tendency in some Commands abroad to produce their own variety of the Charnley caliper, and these models show defects.

The purpose of this paper is to describe the caliper in detail so that the standard model, of proven value during the war, can again be used throughout the Army, either in the United Kingdom, in Commands abroad or during the long chain of medical evacuation from Commands abroad to the United Kingdom; and to point out that there are two types of heel sockets, one for the use of fractured femora and the other for use in fractured tibiæ.

### INTRODUCTION

The Charnley Walking Caliper is not a complete weight-bearing caliper. If this is required (*e.g.*, for aseptic necrosis of the femoral head following a dislocated hip) a caliper with a patten, made to measure by an instrument maker, and with the shoe of the normal side raised, is required. On the other

hand, where a long knee brace only is required, and where weight relief is not the primary function of the caliper, such as in paralysed quadriceps after poliomyelitis, a half ring with a soft front of leather strap and buckle is more comfortable and quite adequate.

Some indications for the temporary use of this caliper are :

### 1. *Fracture of the Femur*

There is no doubt that a well-fitting Charnley caliper can relieve a fractured femur from the major part of the body weight, *but if it does not fit, the splint becomes dangerous and useless.*

(a) Fractured neck of femur after insertion of a Smith-Petersen nail. Some surgeons use it until there is X-ray evidence that the fracture is united.

(b) Trans-trochanteric fractures in young adults. This type of fracture, whether treated conservatively or by open reduction and metallic fixation, is prone to late varus deformity if the fracture is not perfectly reduced or if there is cortical destruction of the medial buttress of the upper end of the lower femoral fragment, and complete weight bearing should be delayed for six months from the fracture date.

(c) Shaft. A caliper is not required as a routine. Certainly the oblique, the spiral and the comminuted fractures unite readily without danger of late angulation or deformity. Transverse fractures with little callus, particularly if the callus is present on one side only, are prone to refracture or to angulate on weight bearing. War wounds of the femoral shaft where bone loss has occurred, and where union has taken place through a frail bony bridge, are an indication for the use of a caliper.

(d) Femoral condyle fractures, where active knee-joint movements is desirable while the fracture is consolidating. The patient is ambulatory with partial weight bearing, permitting intermittent non-weight-bearing exercises to the knee.

(e) Orthopædic surgeons may consider a caliper is a useful adjunct to the operative treatment of fractures of the femoral shaft after Kuntscher nailing.

### 2. *Fractures of the Tibia*

(a) Fractures of the tibial plateau. In the young soldier it is important to prevent the development of late genu valgum. This may be obtained by plaster fixation and the prohibition of weight bearing until the crushed cancellous bone is strong enough to prevent collapse into knock-knee deformity. This period of non-weight-bearing and plaster fixation can be cut short by fitting a Charnley caliper to allow for early ambulation and periodic non-weight-bearing knee movements, if the caliper is removed for certain periods during the day.

(b) Delayed union of tibial shaft fractures. Some fractures of the leg bones show that, although union is proceeding clinically and radiologically, consolidation of that union is delayed beyond the time that these fractures ordinarily unite and consolidate. In these fractures with delayed union there may be a just perceptible range of movement at the fracture site. (If, however, the fracture

at this juncture shows a range of movement of five degrees in any one plane, then pseudo-arthritis is established and a bone grafting operation is required.) It is in these cases of delayed union that caliper walking is valuable, allowing rehabilitation of the limb and the patient to proceed while consolidation of the fracture is occurring. The caliper, however, should only be used provided that :

(i) There is no backward angulation of the fragments.

(ii) The mobile type of heel socket is used.

(c) Orthopædic surgeons may consider the caliper is useful while waiting for the skin to become healthy, particularly in war wounds, prior to bone grafting or bone plating, and again at some stage after these operations.

It must be appreciated that any caliper, and all below-knee irons, either single or double, are attached to the shoe or boot by a heel socket which can be either fixed or mobile.

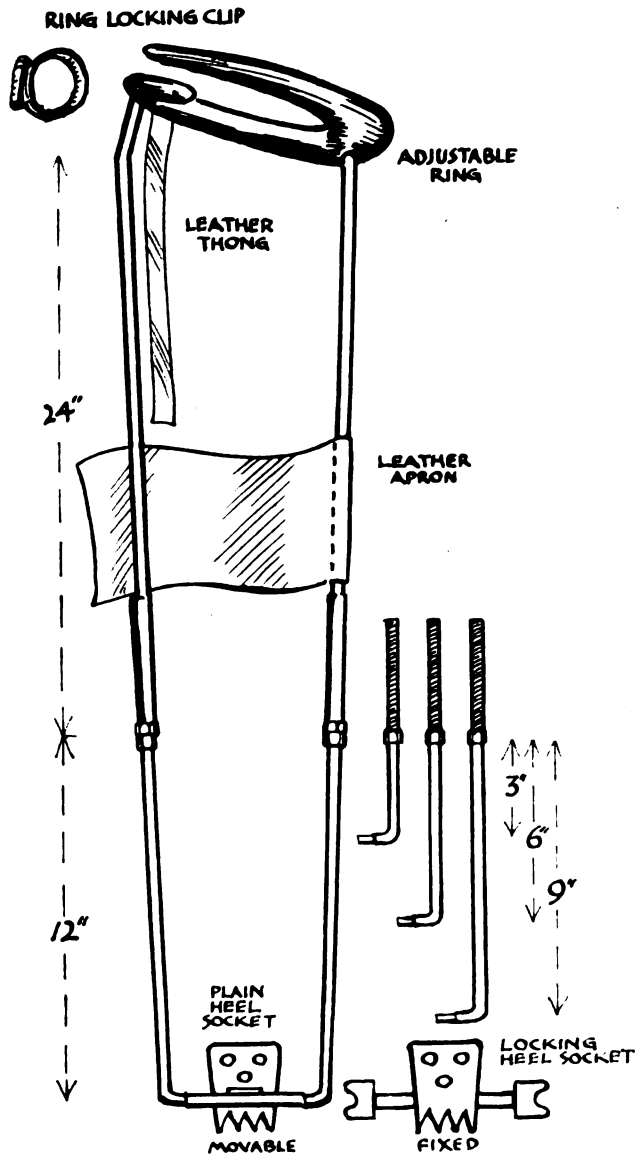
The mobile type for fractures of the tibia must be sited concentric to the ankle joint. If not, anterior/posterior angulation of the lower tibial fragment on the upper will occur and precipitate non-union. In Charnley's caliper the heel socket is mobile, but it is not concentric to the ankle joint. This is of no importance in the treatment of fractured femora, but it is dangerous if used in the treatment of fractured tibiæ. To overcome this, Charnley has recently designed a fixed type of socket to be attached to the boot or shoe. This prevents any ankle-joint movements and is used for the treatment of fractured tibiæ. This type of socket is not in use in the Army. If a more permanent caliper or double or single iron is required, then a fixed heel socket with an ankle-joint movement incorporated in the side bars and concentric to the axis of the anatomical ankle joint is required. This is an iron made to measure by instrument makers, and is expensive.

#### DESCRIPTION OF THE CHARNLEY CALIPER

The *Ring* is made of malleable  $\frac{1}{8}$ -inch mild steel rod padded and covered with leather, and is incomplete on the outer side so that the two free ends overlap. This allows a range of adjustments of the circumference of about 2 inches (1 inch increase and 1 inch decrease). When it is correctly adjusted to the circumference of the root of the limb, the overlapping ends are clipped by a ring clip similar to a hose-pipe clip, and the ring is thus rendered solid and rigid. The loose leather thong is soaked in water and lashed round the rough metal clip, and the end of the tail is tucked into the final turn but one with the points of the artery forceps. The wet thong can be moulded to the surface of the ring and the clip to give a smoother surface and thus protect the neighbouring skin.

The P.L.M.E. contains two sizes (the diameters are not given, but they are 21-inch and 18-inch respectively). Each size can be increased or decreased by 1 inch. These sizes will fit the root of the lower limbs of the vast majority of young adults.

The shape of the ring is that of a simple flat ovoid and is devoid of any surgical shape to fit the ischial tuberosity. The side bars are fitted into the centre of the ovoid. The rings are reversible and do away with the necessity



for rights and lefts. The ovoid shape is achieved by being wider by 1 inch from side to side than from front to back. The ring is set at an angle of 30 degrees to the side bars by making the outer side bar 2 inches longer than the inner side bar, the length of which is 24 inches.

It is Charnley's contention that adequate weight relief is obtained by the simple flat ovoid ring, provided that the circumference of the ring fits closely and comfortably to the circumference of the root of the limb, and that the anatomically shaped ring which fits the root of the limb rather loosely does not, in fact, allow weight bearing on the tuber ischii. In all rings a large part of the weight is taken through the fibrofatty fold of the buttock and the lower border of the gluteus maximus in contraction, and really the ischial tuberosity is only an anatomical landmark for the important accurate fitting of the ring.

**Length Adjustment**—Each ring is supplied with side bars of  $\frac{3}{8}$ -inch-thick mild steel rod welded into the ring and of a standard length measured from the upper surface of the padded ring to the lower end of the adjustable extension socket. The inner side bar is 24 inches long and the outer side bar 2 inches longer and is angulated at the trochanter level to accommodate the shape of the root of the limb. The extension socket consists of a male and female screw thread with a locking nut, which allows of a variation of 3 inches in the length of the side bars. To allow for varying length *Extension Pieces* of  $\frac{3}{8}$ -inch diameter of mild steel rod are issued in pairs in four different sizes. These screw  $\frac{1}{2}$  inch into

the above adjustments, which will then allow a variation of total length of  $3\frac{1}{2}$  inches when the adjustment is used.

The sizes of the extension pieces and the series of leg lengths are 16, 13, 10 and 17 inches. These lengths are those that Charnley now advises and differ from those in the P.L.M.E., which will be amended.

Four inches of each length can be absorbed into the overlap of the socket. For example, in the 16-inch the minimum extra length that can be obtained is 12 inches, but if only  $\frac{1}{2}$  inch is retained in the overlap socket,  $15\frac{1}{2}$  inches extra length is available.

These extension pieces are threaded for 4 inches with  $\frac{3}{8}$ -inch B.S.F. and carry a  $\frac{3}{8}$ -inch B.S.F. locknut. The spur on each is 1 inch long, is at right angles to the shaft, round in shape and turned down to  $\frac{1}{4}$  inch, and at this point may be case-hardened.

The *Heel Socket* is unconventional but an important feature in the rapid fitting of the caliper. It is  $3\frac{3}{8}$  inches wide, which is wide enough to project beyond the sides of the boot, but this, though ugly, allows the side bars of the caliper to clear the prominent medial condyle of the femur and the lateral bulge of the calf. If it is still not wide enough to achieve this the side bars can be bent. The tube socket is  $\frac{1}{8}$  inch inside diameter and is welded to a sole plate which is provided with four sharp steel spikes on its posterior edge. These spikes are driven into the leading edge of the heel on the undersurface of the instep, where it is fixed with wood screws. The socket lies forward of the conventional site and reverts to the original H. O. Thomas site.

Charnley's heel socket is of the mobile type and allows ankle-joint movement. This type only should be used for fractures of the femur.

A posterior support of leather, 4 inches wide, is provided to go behind the popliteal fossa. This is stitched to one side bar and left free at the other end so that it can be stitched or pinned to the other side bar at the appropriate tension when on the patient. The knee is held against the back support by means of a domette bandage wrapped round the knee and splint. This same bandage also holds the side bars together and prevents them jumping out of the heel sockets.

One special feature of the screwed length adjustment is that it enables the limb and therefore the foot to be placed in the required position of rotation; it can be locked permanently in this position by tightening the locknuts.

One of the mechanical defects encountered in using the caliper is the possibility of the screwed adjustment working loose. This should never happen if the locknut is finally tightened using *two* spanners—one to hold the female socket and one to hold the locknut.

#### COMPONENTS

To enable an immediate fitting to be made from stock, it is necessary to carry a stock of parts, and these can be grouped together into sets. A set comprises :

2 Rings—large and small.

4 prs. Extension Pieces—very large, large, short and very short.

4 Heel Sockets.

In practice in peace, a Medical Equipment Depot abroad might be issued with six such sets, together with twice this number of heel sockets, as these elements wear out while the other components do not. In addition, the following kit of fitting tools is required :

2 Spanners, open jaw  $\frac{1}{4}$  inch  $\times$   $\frac{3}{16}$  inch (R.A.O.C. issue).

1 Screwdriver (R.A.O.C. issue).

Several gross of  $\frac{3}{8}$ -inch wood screws (R.A.O.C. issue).

Gimlet (R.A.O.C. issue).

Hammer (R.A.O.C. issue).

Charnley now states that the clamp, ring, bending, is no longer required and it will be deleted from the P.L.M.E.

Once the initial issue from the Depot to a Command Orthopædic Centre is made, replacement of items is small provided that the calipers are returned after use. To keep them in service, all that is needed is renewal of the leather covering to the rings and new heel sockets as they wear out. Extra long and extra short extension pieces are infrequently required.

Whenever a patient has been fitted from stock it is necessary to indent on the Medical Equipment Depot for components to restore the stock of the Orthopædic Centre to full strength, and Depots should keep their own pipelines of replacement filled.

#### TECHNIQUE FOR FITTING THE CALIPER

It is an advantage to have a room where all the tools are readily to hand. The patient should be sufficiently mobile to stand up on crutches with the assistance of an orderly. It is useless to attempt to fit a bed-ridden patient.

With the patient supported on crutches, the fitter stands behind him and the caliper ring is tried on. The posterior half, to which side bars are attached and which supports the region of the tuber ischii, is adjusted first. This is performed by pressing the posterior-medial segment of the ring upwards and outwards until it is buried in the fat under the tuberosity in the position it will take when weight bearing. The air space between the outer aspect of the thigh and the inner surface of the lateral part of the ring is measured. This gives the amount by which the ring must be reduced in its side-to-side diameter. This reduction can be accomplished by compressing it from side to side, or with a hammer. If the ring needs enlarging it can be pulled open by the hands or with added assistance from the surgeon's foot.

The ring is again tried on after dusting it with talcum powder, and if satisfactory the anterior half of the ring is closed down to meet the posterior half until it lies gently against the skin of the anterior surface of the thigh. The ring clip is now applied to the overlapping segments and the wet leather thong is lashed over it as previously described.

The heel socket is now applied and screwed home. A pair of extension pieces is chosen from the set likely to give the correct over-all length to the caliper, and the splint is reapplied. The correct length is to allow a clearance of  $\frac{1}{4}$  inch between the skin of the under surface of the heel and the upper surface of the bottom of the boot. The foot should be neither inverted nor everted. The locknuts are then tightened with two spanners, one holding the female socket and the other the locknut. This final tightening is best done with the splint off the patient.

The back support is adjusted to the popliteal surface of the thigh and leg and is pinned to the outer bar. A domette or flannel bandage is applied and the result inspected. There should be no space between the greater trochanter and the outer side of the ring. It should be away from the anus. The fit of the ring should be such that a little effort is needed to pull it fully into the root of the limb. The caliper should be worn directly against the skin. The patient should not be walking with the toes turned in. This can be prevented by everting the foot to the desired degree before finally tightening the locknuts. The heel of the normal boot should be raised  $\frac{3}{4}$  inch and the patient instructed to sit well back on the ring, so as to keep the hip extended and so avoid pressure on the adductor regions of the groin by hip flexion. The patient is allowed to walk with crutches or with a stick until he chooses to discard them. He should acquire a good gait, and not a caliper roll, before a stick is dispensed with. This should be impressed on the physiotherapist. Caliper walking should be graduated until the patient can use it for the whole day. This may take a week or two. Periodically the caliper should be inspected as follows: The fibrofatty pad and the gluteus maximus should be well on the ring if the ring fits circumferentially when the patient stands on this limb. The patient should not be able to feel his heel touching the bottom of the boot.

Sometimes when the caliper is fitted there is difficulty in getting the patient's boot on. Heavy dusting with talcum powder on the outside of the sock helps. A larger size of boot may be necessary. Sometimes there is pressure on the back of the heel, which should be relieved by cutting out the back of the boot.

#### SUMMARY

The War Office pattern of the Charnley caliper is a useful instrument in the treatment of fractures of the lower limb. It should be clearly understood that in femoral fractures it is dangerous unless it is well fitted to the root of the limb and that this caliper, with Charnley's type of mobile heel-socket, should not be used in the treatment of fractures of the tibial shaft.

#### ACKNOWLEDGMENTS

The components of the War Office pattern Charnley caliper are made for the Army by the R.E.M.E.

This caliper is also made commercially by the London Splint Company, who have kindly lent me the block of the diagram of the splint.

I wish to thank the Director of Surgery, Brigadier J. Huston, F.R.C.S.(Edin.), and Mr. John Charnley for their suggestions when this paper was being prepared.



## THE THORACO-BRACHIAL PLASTER

BY

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THE main problem of a forward surgeon is to make casualties comfortable and transportable after operation.

In the last war the best method of transporting gunshot wounds of the lower limb was found to be a Tobruk plaster. This plaster was put on after the first-aid surgery of wound toilet, hæmostasis and sterile dressing had been done. Each surgeon had his own variations of application, but the principle was that the leg, and the Thomas's splint in which it lay, were bound together by plaster of paris so that they moved as one. In my own experience the best method of doing this was to mould the plaster to the thigh before the plaster set.

In wounds of the upper limb, and in simple or compound fractures of the humerus, the same principles apply. After surgical toilet, if the arm is bound to the chest by a light moulded plaster (thoraco-brachial), the arm and thorax move as one piece and the patient travels in comfort. As most wound toilets are done under Pentothal anæsthesia it is possible within two hours to sit the patient upright on a stool for the application of the plaster. It is very important that the thoraco-brachial plaster be put on with the patient in a sitting posture under analgesia but not under anæsthesia. Once the plaster is applied the patient can sit, stand or lie down in comfort. If the plaster is applied while the patient is still anæsthetized at the conclusion of his first operation, the muscles are relaxed and the postural position is wrong. In such a plaster the patient is only comfortable when he is lying down.

The thoraco-brachial plaster is applied after an intravenous injection of morphine (gr.  $\frac{1}{4}$  to gr.  $\frac{1}{2}$ ). Under this analgesia it is possible to manipulate the fracture without causing pain to the casualty.

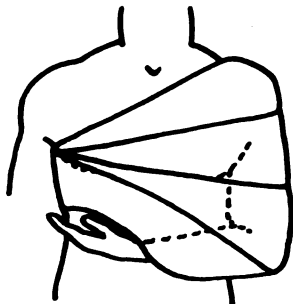
A light plaster which has only eight to ten layers of bandage anywhere can be applied within ten minutes and only requires six 6-inch "Cellona" or "Gypsona" bandages. If the patient has a dropped wrist due to radial nerve injury, it is sometimes advisable to put on a small cock-up splint. The splint should be 2 inches wide by 9 inches long and at least ten layers thick. This can easily be made by turning in a 6-inch bandage to the required width.

### PROCEDURE

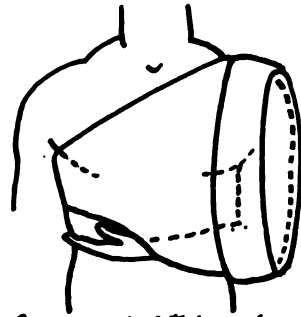
Supposing the injured arm to be the left, the patient is seated on a stool, his uninjured arm supported by an orderly. The injured arm is brought across the chest with the forearm in supination. After applying a thin layer of padding,

the first bandage is started like a fan from under the right axilla over the left shoulder, arm and forearm (Fig. 1). The second bandage is applied vertically around the left shoulder and under the elbow (Fig. 2). As we already have four

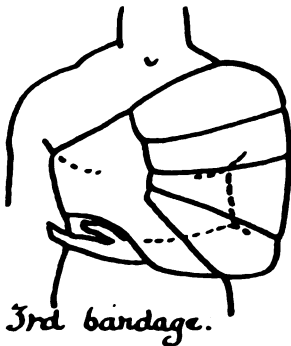
### Thoraco-brachial Plaster.



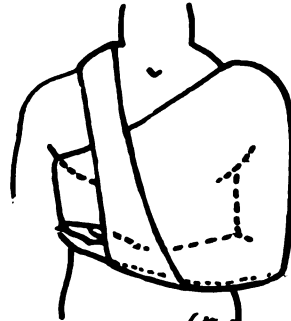
1st and 5th bandage.



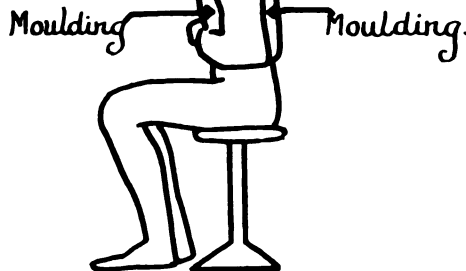
2nd and 4th bandage.



3rd bandage.



6th bandage.



thicknesses along the right side of the chest, the third bandage is only brought midway on the chest and from there fans out to the mid-line of the back over the shoulder, arm and forearm (Fig. 3). The fourth bandage is applied similarly to the second as a vertical layer running over the shoulder and under the elbow (Fig. 2). The fifth bandage is used to tie them all together again and is exactly

similar in application to the first (Fig. 1). This leaves a plaster with eight layers over the right side of the chest and eight to ten layers in front and behind the injured arm. Now comes the crucial step. Firm pressure with two hands is put into the grooves between the arm and the chest wall to mould the plaster firmly around the arm and chest. Pressure need only be exerted for three to four minutes until the plaster sets. When this moulding is finished, the sixth bandage, in the form of a ready-made slab, is brought from behind the left shoulder over the right shoulder and down under the left forearm (Fig. 4). In this position it not only acts as a sling for the left forearm but keeps blankets from pressing on the hand.

I remember an officer coming to 5 F.S.U. at Ben Gardine, Tunisia. He had fallen from a lorry on to his right shoulder. X-ray showed a simple fracture of the right humerus. He begged me not to send him down as a casualty because he had all the rations for three hundred men who were going to be left out of the battle of Mareth, and he was the only officer who knew where the men were. He was reassured and told that he could be fitted up with a thoraco-brachial plaster which would allow him to travel and to complete his mission. Within fifteen minutes he had his thoraco-brachial plaster applied and in an hour's time he took off over the desert with his driver to deliver the rations. I did not see him on his return, but he was evacuated to Egypt the next day. Later I had a letter from him telling me that he had been absolutely comfortable both on his desert journey and on the long trek down to Egypt. In fact, he was so comfortable that when he arrived at the Base Hospital, where a check X-ray showed reasonable position of the fracture, his thoraco-brachial plaster was not removed. When he came out of the plaster he was able to go into a collar-and-cuff sling and start remedial exercises. He had had no loss of movement of his elbow because in the plaster he was able to use his fingers and wrist.

The use of a thoraco-brachial plaster is strongly advised for all simple or compound fractures of the humerus and for any large wound of the shoulder region. A wound only travels comfortably when it is immobilized and there is no better immobilization than by plaster of paris.

[Editor's note : This method is advocated in *A Field Surgery Pocket Book* (Revised, 1950), and is taught to all officers attending courses at the Royal Army Medical College.]

# A CASE OF JAPANESE B ENCEPHALITIS

BY

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and

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*(From the Department of Bacteriology, the University of Malaya, and the Command Laboratory of the Far East Land Forces.)*

THE following case is reported as it may be of interest to R.A.M.C. officers who might at some time serve in Malaya.

## CLINICAL FINDINGS

A private soldier aged 19 was admitted to the British Military Hospital, Kluang, on 26th January, 1952. He had a two days' history of headache; there was no vomiting, but on the day prior to admission he had been unconscious for a period of twenty minutes. At the time of admission the temperature was 99° F. and the cerebro-spinal fluid (C.S.F.), which was sterile, contained 22 cells per c.cm., 71 per cent. of which were polymorphs and 29 per cent. lymphocytes.

27.1.52. The patient was drowsy and showed a tendency to reversal of sleep rhythm. The temperature was over 102° F., and at this time there was some neck rigidity: otherwise examination of the central nervous system was negative. At 1600 hours he had an epileptiform convulsion. The C.S.F. was slightly turbid; the protein was 60 mg. per cent., and cells 155 per c.cm. Of these 95 per cent. were polymorphs and 5 per cent. lymphocytes.

28.1.52. At this stage he was comatose and incontinent. There was a slight stiffness of the neck and later in the day he had a second epileptiform convulsion and developed athetoid movements of the right arm. The C.S.F. contained 114 cells per c.cm., but the cell picture had changed, for now 69 per cent. were lymphocytes and only 31 per cent. polymorphs. In the evening he had passed into a deep coma and the temperature was 104° F. 750 micrograms of chloramphenicol were given intrathecally.

29.1.52. The coma was lighter and the patient showed photophobia. The cell count of the C.S.F. had risen to 970 per c.cm., 91 per cent. of which were lymphocytes and 9 per cent. polymorphs. A further 750 micrograms of chloramphenicol were given intrathecally, but later there was a sudden onset of dyspnoea and respiratory embarrassment and the patient died in the early hours of the following day.

## PATHOLOGICAL FINDINGS

Apart from the brain, the other organs showed congestion and evidence of toxic changes. Both hemispheres of the brain were slightly hyperæmic, while the brain stem and pons showed frank congestion.

*Histology.*—Sections made from the pre-central, post-central and hippocampal gyri and the thalamus all showed perivascular lymphocytic cuffing and scattered foci of neuronal degeneration. Associated with these areas there were accumulations of neuroglial cells and lymphocytes (Fig. 1), and in some neuronophagia was also present. The cerebellum showed slight inconstant perivascular cuffing and degeneration of the Purkinje cells. The changes in the spinal cord were similar to those found in poliomyelitis. There was cellular infiltration and some neuronal degeneration (Fig. 2).

TABLE I.—SUSCEPTIBILITY OF CERTAIN LABORATORY ANIMALS TO GROUP OF NEUROTROPIC VIRUSES (ON PRIMARY ISOLATION)

Virus	Mice 3 weeks old		Guinea Pigs 250 gms. +		Rabbits		Monkeys
	I.C.	I.P.	I.C.	I.P.	I.C.	I.P.	I.C.
Western Equine ...	++++	+	++++	++	+++	±	++++
Venezuela Equine ...	++++	++++	++++	++++	++++	++++	++++
St. Louis ...	++++	±	±	0	0	0	±
Lymphocytic chorio- meningitis ...	++++	±	++++	+++	0	0	+
Theiler's Virus ...	+	0	0	0	0	0	0
Japanese B ...	++++	++	±	0	0	0	+++
Virus isolated from Mili- tary Case ...	++++	+++	±	0	0	0	+++

I.C.=intracerebral inoculation. I.P.=intraperitoneal inoculation. Table taken from *Diagnostic Procedures for Virus and Rickettsial Diseases*.

## LABORATORY INVESTIGATIONS

A post-mortem was conducted within two hours of death and portions of the brain and the spinal cord were placed in a container refrigerated with dry ice for transport to Singapore.

The material was ground up with sterile sand in nutrient broth to give a 20 per cent. w/v suspension. After centrifuging, 0.03 ml. of the clear supernatant fluid was inoculated intracerebrally into three-weeks'-old Swiss mice. Within four to five days infected mice showed convulsions, were ataxic, and some were paralysed in the hind limbs. These were sacrificed and 1 per cent. suspensions of their brains passaged into other mice. By such means the infection could be maintained indefinitely, and a bacteriologically sterile filtrate of such a suspension prepared by the use of 0.69  $\mu$  gradacol membrane filter (Elford, 1931) resulted in an infection of the mice and thus the virus ætiology was established.

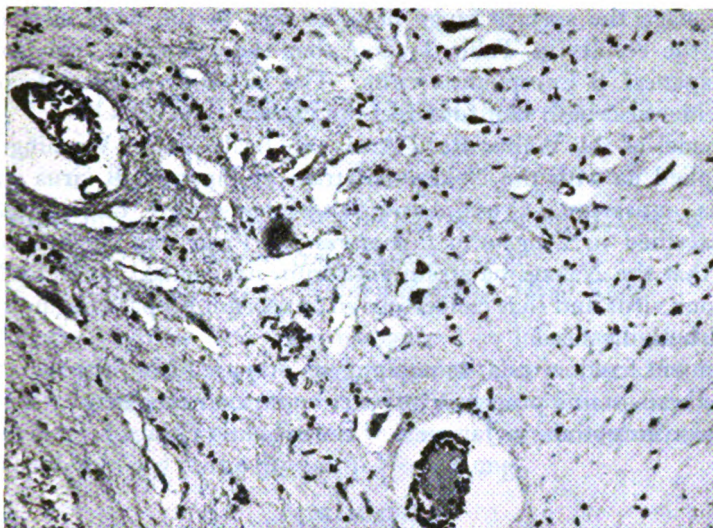


FIG. 1

SECTION OF SPINAL CORD SHOWING INFILTRATION AND COMMENCING  
DEGENERATION OF NERVES

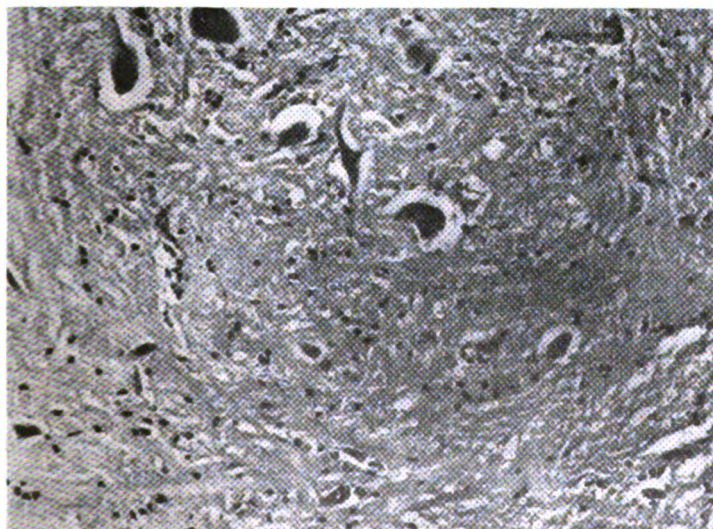


FIG. 2

SECTION OF HUMAN CORTEX SHOWING LYMPHOCYTIC PERIVASCULAR  
CUFFING AND CELLULAR INFILTRATION

At this stage the species range of infectivity of the virus suspension was tested and the results in Table I show that the strain we had isolated was probably Japanese B Encephalitis virus. The histology of the infected animal brains was identical with that found in the patient.

Dr. Smadel of the Walter Reed Army Medical Centre, Washington, D.C., kindly supplied us with the Nakayama strain of Japanese B virus and also its homologous antiserum. Cross-neutralization tests were carried out by the method described in *Diagnostic Procedures for Virus and Rickettsial Diseases*. We found that the Nakayama strain antiserum neutralized both the Nakayama strain and our virus and that conversely an antiserum prepared against our virus neutralized both strains.

Complement fixation tests, using antigens prepared from the two strains and antisera to these strains prepared in mice, confirmed the identity of our strain with the Nakayama strain of Japanese B Encephalitis virus.

#### SUMMARY

The clinical and pathological findings in case of a Japanese type B Encephalitis are described.

The diagnosis was established by the isolation and serological identification of the virus.

#### ACKNOWLEDGMENTS

We wish to thank Dr. Smadel of the Walter Reed Army Medical Centre for kindly supplying the Nakayama strain of Japanese B Encephalitis virus and a sample of homologous antiserum. One of us (P. C. F.) is also indebted to the Under-Secretary of State for War and the Director of Medical Services, Far East Land Forces, for permission to publish.

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## SCRUB TYPHUS IN HONG KONG

BY

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CASES of scrub typhus have been recognized by local medical authorities in Hong Kong for a number of years, but no account can be traced of the evidence on which the diagnosis has been based. The purpose of this paper is to present the results of serological investigations in cases of scrub typhus and to review briefly the epidemiology of the disease in Hong Kong.

### INTRODUCTION

Scrub typhus is a disease caused by *Rickettsia orientalis* and is transmitted from reservoirs in rodents to man by the larvæ of the mites *Trombicula akamushi* and *Trombicula deliensis*. This disease is widespread throughout the Far East. Textbooks on tropical medicine include Northern China among the areas where scrub typhus is found, but make no mention of Hong Kong. Simmons *et al.* (1944) in their review of epidemic diseases in the Far East give Wuchang, Hupeh and other sections of the lower Yangtze valley as the provinces of China where scrub typhus has been reported and note only epidemic and endemic typhus in Hong Kong. Audy (1951) referred to the occurrence of scrub typhus in Hong Kong when discussing the epidemiology of this disease.

### YEARS UP TO 1941

Many of the records relating to the years before the Japanese occupation of Hong Kong have been destroyed, but Gray (1952) saw eight cases, six military and two European civilians, in the year 1941 in which the diagnosis of scrub typhus was made. The results of the Weil-Felix reaction are available in four cases only, of which three showed a tenfold rise in titre against OXK, the highest titre observed being 1 in 250, 1 in 1,250 and 1 in 2,500 respectively. One of these cases was fatal, but all post-mortem material was lost during the occupation.

### 1945-1950 : CIVILIAN CASES

It is understood that since the end of the last war sporadic cases of scrub typhus have been notified in Hong Kong, but little information is available. As the annual reports by the Director of Medical Services, Hong Kong, show only the total number of cases of typhus fever notified, it is not possible to determine from these reports alone what proportion were scrub typhus. The annual report for 1950, however, shows one death from mite-borne typhus, but gives no details (Report, 1951). Duck (1949), working in the Government laboratory,



examined sera from cases thought to be typhus fever and during 1946-1949 found five which gave a titre of 1 in 400 or over, and two a titre of 1 in 200, with *Proteus* OXK.

#### 1945-1949 : MILITARY CASES

The records of the laboratory at the Military Hospital, Hong Kong, reveal that six sera from six different patients, five military and one civilian (nationality not stated), examined during 1947 gave titres of over 1 in 320 against OXK and low or negative titres against OX19 and OX2. Only one Weil-Felix test appears to have been performed in each case, and as no relevant clinical details are available it cannot be stated, with any certainty, that these were cases of scrub typhus.

In 1949, Captain G. A. K. Missen, R.A.M.C., examined sera from five military cases which were clinical scrub typhus and demonstrated a considerable rise in titre against OXK during the course of their illness (see Table I).

TABLE I.—MILITARY CASES, 1949

Case	Onset	Titre against OXK	
		Initial	Highest
A	May ...	1 in 250	1 in 1,000
B	August ...	1 in 25	1 in 250
C	August ...	1 in 50	1 in 1,000
D	October ...	1 in 50	1 in 250
E	October ...	1 in 125	1 in 1,000

#### 1950-1951 : MILITARY CASES

During 1950 and 1951 ten cases were diagnosed as scrub typhus on clinical and serological grounds. A few cases where the clinical picture or the serological evidence was unconvincing have been omitted from the series. All cases were in British troops.

#### Laboratory Investigations

As the majority of the cases were admitted to hospital with a diagnosis of P.U.O., certain laboratory investigations were carried out—*e.g.*, white blood counts, thick films for malarial parasites, etc.—but the only significant positive findings were those of the Weil-Felix reactions. The Weil-Felix reactions were carried out by the method described by Felix (1944) using suspensions as fresh as possible. Serum was obtained on several occasions from each patient during his stay in hospital and when possible after his discharge. The results of the Weil-Felix reactions are shown in Table II. The titres against OXK only are given in this table as the titres against OX19 and OX2 were not significant.

It is regretted that it was impossible to carry out any animal inoculation experiments.

#### Treatment

Chloromycetin was given if the clinical condition warranted this. All cases recovered.

TABLE II.—MILITARY CASES, 1950-51

Case No.	Onset	Titre against OXK		
		Initial	Highest	Last
1	January, 1950 ...	1 in 80	1 in 1,280	1 in 320
2	September, 1950 ...	1 in 40	1 in 640	1 in 160
3	September, 1950 ...	1 in 40	1 in 160	1 in 40
4	September, 1950 ...	1 in 2,560	1 in 2,560	1 in 1,280
5	September, 1950 ...	1 in 320	1 in 320	1 in 80
6	October, 1950 ...	1 in 80	1 in 640	1 in 80
7	June, 1951 ...	1 in 20	1 in 160	1 in 40
8	June, 1951 ...	1 in 20	1 in 320	1 in 80
9	August, 1951 ...	1 in 10,240	1 in 10,240	—
10	October, 1951 ...	1 in 320	1 in 640	1 in 320

*Illustrative Case History*

Sgt. O'S., aged 26. His illness commenced on 3rd January, 1950, when he developed severe headache, general malaise and shivering. He was admitted to a Field Ambulance on 5th January and transferred to the General Hospital on 10th January with a diagnosis of P.U.O. Cervical gland enlargement had been noted on 8th January.

On admission his temperature was 101·2° F., pulse 86 and respiration 20. A rather faint roseolar rash was present on the chest, abdomen, lumbar region and shoulders, but not on the arms or legs. There was an oval, crusted eschar just below the umbilicus. Rubbery discrete glands were palpable in the neck, axilla and groins; they were not tender. The spleen was just palpable. On 10th January the W.B. count was 10,200 per c.mm. with polymorphs 60 per cent., lymphocytes 28 per cent. and monocytes 12 per cent. The rash had faded by 13th January. The Paul-Bunnell test carried out on serum obtained on 14th January was negative. The temperature fell by lysis and remained normal after 15th January. Recovery was uninterrupted.

TABLE III.—CASE No. 1

Days after onset	Reading of OXK Titres	
	Hong Kong	London
7	1 in 80	•
10	1 in 160	1 in 160
13	1 in 640	1 in 500
16	1 in 1,280	1 in 1,000
21	1 in 640	1 in 1,000
35	1 in 320	•
76	•	1 in 100

\*Not examined.

Serum for Weil-Felix reaction was obtained at three-day intervals for 9 days and further specimens were taken 21, 35 and 76 days after the onset. Each sample of serum was divided in two; one was examined in Hong Kong and the other sent to Dr. Felix, who repeated the tests in London. The results obtained are shown in Table III. The titres against OX19 and OX2 were not significant. Dr. Felix considered that this was undoubtedly a case of scrub typhus (Felix, 1950).

*Weil-Felix Reaction in other Febrile Diseases*

During the period in question Weil-Felix reactions were carried out on a number of sera from patients suffering from various febrile diseases finally diagnosed as other than scrub typhus. The titre of agglutinins for OXK was usually in the range 1 in 20 to 1 in 80. Titres of 1 in 160 and 1 in 320 were recorded on a few occasions.

## TOPOGRAPHY

The British Crown Colony of Hong Kong comprises the island of Hong Kong, the Kowloon peninsula and the New Territories which include a part of the mainland leased to Britain, together with a number of islands. The total area of the Colony is about 400 square miles. A large port has been developed in the enclosed waters between Hong Kong island and the mainland.

The island of Hong Kong is some eleven miles long and from two to five miles broad. It consists of an irregular range of hills. The Kowloon peninsula and the New Territories are mainly hilly, although there are extensive areas of flat ground in the north-west of the New Territories.

At the western end of the harbour is a small island known as Stonecutter's Island. This island is about one mile long by one-third of a mile broad and only a few hundred feet in height at its highest point.

Afforestation has been carried out, particularly on Hong Kong island, with considerable success. The lower slopes of the hills are well covered with vegetation. Scrub is common. In one area on Stonecutter's Island the vegetation had been cleared some years ago to make a football pitch, but secondary growth had taken place around the edges by 1949.

## CLIMATE

Hong Kong has a subtropical climate of a monsoon type. During summer the relative humidity is high and the temperature around 80° F. ; in winter the relative humidity is lower and the temperature around 60° F. The annual rainfall is 85 inches, of which two-thirds falls from June to September.

## EPIDEMIOLOGY

The eight cases seen by Gray in 1941 occurred among personnel stationed on Hong Kong and in the New Territories (Gray, 1952). From the information available it would appear that of the five military cases recorded in 1949, two were infected on Hong Kong and three on Stonecutter's Island, and that most of the cases recorded in 1950-1 (Table II) were infected in the New Territories.

Audy (1951, 1952) examined the ears of rats trapped during 1949-1950 on Stonecutter's and Hong Kong Islands and found *T. deliensis*, a known vector of scrub typhus, in specimens collected in the hot wet period, but species of *Eushongastia* in those collected in the cool dry season. From this information he concluded that the scrub typhus season in Hong Kong was probably distinct, occurring roughly between May and October. Fourteen of the fifteen cases enumerated in Tables I and II occurred within this period, as did seven of the

eight cases seen by Gray in 1940-1. This evidence supports Audy's contention that the "typhus season" in Hong Kong is between May and October.

In an attempt to discover evidence of infection in the likely reservoir, the rat, blood was obtained by Mr. J. D. Romer, the Government Rodent Control Officer, from rats trapped on Stonecutter's Island between September and November, 1949, and the serum titrated against OXK suspensions. Six sera gave a titre of only 1 in 25. The remainder showed no demonstrable antibody.

#### DISCUSSION

It has long been recognized that suspensions of *Proteus* OXK are more susceptible to non-specific agglutination by sera of man than are suspensions of OX2 and OX19. Further, OXK suspensions are unstable and may consequently be agglutinated by relatively high dilutions of serum from patients who are suffering from diseases other than scrub typhus.

There is a divergence of opinion as to what titre may be regarded as diagnostic of an active infection in scrub typhus. Felix (1944) states that when a patient's serum is examined for the first time, complete agglutination with OXK at 1 in 160 or 1 in 200 may be taken as diagnostic of an active infection and that a rise of titre of at least 100 per cent. may be considered a significant reaction provided that a properly checked suspension is used. Lewthwaite and Savor (1940) consider that a titre of 1 in 125 against OXK may be regarded as evidence of infection if the clinical condition is that of scrub typhus, but point out that titres as high as 1 in 480 may be found in leptospirosis. Giles and Symington (1950), however, found titres of as high as 1 in 400 occurring regularly as the result of non-specific stimulation. In the series studied by the author and reported in this paper (Table II) the highest titre recorded varied considerably from case to case, although in every instance it was 1 in 160 or more. The majority of cases showed a twofold or greater rise in agglutinin titre against OXK during the course of the disease, and in many it was possible by repeated examination to demonstrate the waxing and waning titre which Lewthwaite and Savor (1940) regard as almost certain proof of active infection.

The agglutinin titre usually rises late in the course of scrub typhus and thus the Weil-Felix reaction is of limited value in early diagnosis. This late rise of agglutinin titre was noted in many of the cases reported in this paper, *e.g.*, Case 1 (Table III).

#### CONCLUSIONS

The results of the Weil-Felix reactions in cases of scrub typhus in Hong Kong during 1950-51 are recorded.

The available findings of previous workers are noted.

The occurrence of scrub typhus in Hong Kong has been confirmed by serological methods.

Over 90 per cent. of the cases occurred between May and October.

A brief description of the topography of Hong Kong and a few facts relating to the epidemiology of scrub typhus in the Colony are given.

## ACKNOWLEDGMENTS

My thanks are due to Dr. Felix for repeating certain of the Weil-Felix tests and for his advice ; to Dr. Gray for the information on the pre-war years ; to Dr. Audy for making available the results of his entomological researches ; to the laboratory staff of 33 General Hospital for technical assistance ; and to my colleagues, especially Captain G. A. K. Missen, for their co-operation. I am indebted to the Director of Pathology for permission to publish this article.

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## AN INVESTIGATION OF FOOT AILMENTS IN INFANTRY RECRUITS

BY

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THE foot troubles of the soldier have become proverbial and, in war-time conditions particularly, they present an appreciable military problem. Melville (1909), for example, stated that thirty thousand German soldiers were incapacitated by foot ailments during the Franco-German war, whilst reports by Bingham (1944), Burkitt (1941), Burnham (1944), and Schmier (1946) emphasized that the problem was still one of considerable magnitude during the 1939-1945 war. Recent surveys of troops in home stations by Matthews (1946), Hopkins *et al.* (1947), and Davies (1952), who studied fungus infections of the feet, and by Kark (1944) and Berkman (1944), who studied forefoot pain and foot strain in patients attending surgical and orthopædic clinics, demonstrated that a large number of these soldiers suffered from foot complaints. In tropical climates, of

course, fungus infections are very prevalent and cause serious manpower loss. The Canadian army foot survey (1947) drew attention to the importance of foot ailments in recruits and reported that 25.8 per cent. of infantry recruits became foot casualties during their sixteen weeks of training. The actual percentage of foot casualties may have been even higher than this, as a proportion of the recruits were only studied in the first eight weeks of training.

Several factors are responsible for this disturbing incidence of foot ailments. Structural abnormalities of the feet, many of which give rise to symptoms for the first time when subjected to the stresses and strains of service conditions, are known to be very important. The Canadian army foot survey (1947) recorded that, of the recruits who became foot casualties, more than 50 per cent. had foot defects prior to enlistment which, on clinical and radiological grounds, were considered liable to give rise to symptoms. Ill-fitting boots (found in 14 per cent. of Canadian recruits), poor foot hygiene, and undarned, badly darned, or dirty socks are believed also to be factors contributing to foot ailments in the Service.

It appears important to discover :

- (a) What percentage of British soldiers would develop foot ailments if all these factors were, as far as possible, eliminated.
- (b) What type of foot trouble would arise under these circumstances.

The results of seven months' experience in the basic training unit of an infantry regiment in the United Kingdom are presented in an attempt to give an answer to these questions, in relation to infantry recruits.

#### SCOPE OF THE INVESTIGATION

During a period of seven months, January to July, 1952, inclusive, 623 recruits passed through a basic training unit undergoing a six weeks' programme of infantry training. All except 39 had previously been manual workers. Their ages ranged from 17½ to 23 years. They had all been examined by a Ministry of Labour Medical Board before enlistment and were carefully re-examined by the unit medical officer on their first day in the Army. All doubtful cases were referred for special investigation and for the opinion of the appropriate specialist. Recruits with any defect, including any foot condition which appeared likely to cause trouble when subjected to the rigours of military service, were not accepted for infantry training, but were either transferred to another arm of the Service or discharged on medical grounds. When this assessment was being made, far more attention was given to the function of the feet than to their shape or anatomical variations. It should be added that recruits were also tested and interviewed by the personnel selection officer and referred to a psychiatrist if considered necessary, in order to exclude men with gross psychiatric disorders and men in low mental categories.

Every effort was made to see that the recruits received satisfactory boots in accordance with the instructions contained in Clothing Regulations (1943). Soon after arrival, the recruits were given hygiene lectures in which the impor-

tance of personal cleanliness and care of the feet was emphasized. Moreover, the ablutions and the laundering and drying facilities were good, and unit hygiene regulations were strictly enforced. The cookhouse was clean and well-run; the barrack rooms were attractive and comfortable; regimental pride was strong and morale good. In the last week of training every recruit was called upon to pass the standard P.T. tests which include a five-mile quick march, and after the completion of these tests, each underwent a further medical examination.

## RESULTS

A record was kept of every patient seen by the unit medical officer. If a recruit attended the unit medical centre more than once with the same complaint, the second and subsequent attendances were disregarded for the purpose of this study; but if he presented again with an entirely different complaint, he was regarded as a new patient. During the period of study 359 new patients were seen and their complaints were classified into the groups shown in Table I. The foot and ankle conditions were further analysed into the subgroups shown in Table II.

TABLE I

1. Foot and ankle conditions	...	...	...	...	...	...	...	...	...	69
2. Respiratory infections and diseases including coryza, "sore throat," rubella, and pneumonia	...	...	...	...	...	...	...	...	...	43
3. Complaints following vaccination and T.A.B. inoculation	...	...	...	...	...	...	...	...	...	43
4. Miscellaneous painful conditions: tenosynovitis, "rheumatic" pains, etc. (excluding conditions recorded in (1))	...	...	...	...	...	...	...	...	...	43
5. All injuries due to direct and sudden trauma, sudden strains, falls, etc. (except foot injury)	...	...	...	...	...	...	...	...	...	35
6. Gastro-intestinal disorders	...	...	...	...	...	...	...	...	...	29
7. Dental complaints	...	...	...	...	...	...	...	...	...	24
8. Staphylococcal infections: boils, septic hands and fingers, styes, etc.	...	...	...	...	...	...	...	...	...	20
9. Skin conditions (excluding conditions recorded in (1) and (8))	...	...	...	...	...	...	...	...	...	19
10. Ear, nose and throat conditions (excluding conditions recorded in (2))	...	...	...	...	...	...	...	...	...	15
11. Eye conditions (excluding styes)	...	...	...	...	...	...	...	...	...	6
12. Psychiatric conditions	...	...	...	...	...	...	...	...	...	6
13. Other	...	...	...	...	...	...	...	...	...	7
										359

TABLE II

(The definition of subgroups A-D is discussed below)

A. Painful heel	...	...	...	...	...	...	...	...	...	15
B. Blistered and sore feet	...	...	...	...	...	...	...	...	...	15
C. All injuries from direct and sudden trauma, sudden strain, etc.	...	...	...	...	...	...	...	...	...	14
D. Lesions of tendo calcaneus and neighbouring structures—peritendinitis, post-calcaneal bursitis (superficial or deep), etc.	...	...	...	...	...	...	...	...	...	7
E. Fungus infections	...	...	...	...	...	...	...	...	...	4
F. Corns and callouses	...	...	...	...	...	...	...	...	...	4
G. Symptomatic structural defects (pes planus, etc.)	...	...	...	...	...	...	...	...	...	2
H. Undiagnosed pain of arch or ball of foot	...	...	...	...	...	...	...	...	...	3
I. Miscellaneous	...	...	...	...	...	...	...	...	...	5
										69

## DISCUSSION

It may appear surprising at first sight that as many as 359 complaints should arise in these recruits, in view of the selection factors described, the high standard of hygiene, and excellent morale. However, such a number was to be expected in recruits who were adapting themselves to the unaccustomed rigours of infantry training, living for the first time as members of a barrack-room community, with all the increased possibilities of infection, and being subjected to the standard immunological procedures. Nevertheless, it is noteworthy that foot and ankle ailments formed easily the largest group and occurred in approximately 11 per cent. of these recruits during their basic training.

The preventive measures outlined above were carried out conscientiously and efficiently. The fitting of boots was very satisfactory and in only one patient (who had blisters) could ill-fitting boots be regarded as responsible for the foot ailment. The feet of the recruits were found to be clean, whether examined on the sick parade or during surprise inspections, though in the case of two patients a note was made that the socks needed washing. The importance of efficient pre-selection of recruits was also demonstrated. Burkitt (1941) and Kark (1944) have emphasized the high incidence of foot-strain, painful flat foot, and other fore-foot disabilities in the British army, but in this survey only two patients (subgroup G) had this type of foot trouble. In each case, the symptoms were due to a structural defect of the foot which had previously been noted but considered unlikely to give rise to symptoms during training. The four patients in subgroup F experienced no further symptoms after treatment by a chiropodist, whilst the three patients in subgroup H, who were thought to have minor strains, were all back in full training within four days and completed the training programme without further trouble. Structural defects of the feet were not, however, present in any of these seven patients.

The three most important subgroups of foot ailments, as regards incidence, were blistered and sore feet (B), injuries from direct and sudden trauma or sudden strain (C), and painful conditions of the heel (A and D).

Fifteen patients were seen with blistered and sore feet (subgroup B ; acute conditions produced by friction or pressure upon the skin of the foot and ankle). These represent by no means all the sore feet which occurred, since small lesions, without blistering and causing little discomfort, were treated by the recruits themselves with the help and advice of the unit foot orderly. (Interdigital lesions, where the only complaint was the cracking and softening of the skin in one or two interdigital spaces, were also treated in this way.) The Canadian army foot survey (1947) found 27 patients with blisters amongst 970 infantry men in training and drew attention to poorly-fitting boots, dirty socks, wet feet, and malformations of the foot as important factors in blister production. In this present investigation the main factor was thought to be the combined effect of new boots and unaccustomed "foot slogging."

Injuries of the foot and ankle (subgroup C), including eight ankle sprains, need no special comment. They were due to direct and sudden trauma, sudden



strain, etc., and included injuries sustained whilst off duty and whilst on the sports field, as well as those sustained during training.

Painful conditions of the heel (subgroups A and D) can be classified as follows :

- (i) Traumatic.
- (ii) Pathological.
- (iii) Static (Tower, 1938).

(i) The "traumatic" conditions (subgroup D) include peritendinitis of the tendo calcaneus, enlargement and inflammation of the subcalcaneal and post-calcaneal bursæ, march fracture of the calcaneum, and periostitis at the insertion of the tendo calcaneus. Seven patients suffered from complaints of this group. Peritendinitis crepitans of the tendo calcaneus is common in the army (Volk, 1944 ; Johnson, 1945). Volk (1944) attributes the condition to oft-repeated minor strains acting upon a structure accustomed to a relatively sedentary régime, but it is sometimes caused by the lower end of gaiter which produces a crease in the boot and thereby presses upon the tendon (Williams, 1941). The bursal enlargements and inflammations are also caused by repeated minor injuries or pressure (Hentzler, 1926 ; Roberts, 1929).

(ii) The pathological group consists of disorders such as tuberculosis, pyogenic infections and spurs of the calcaneum. No cases were seen in this present series.

(iii) The static group (subgroup A in this investigation) is composed of a number of painful conditions of the heel which are characterized by the absence of visible signs. They are often associated with a change of habit to a more active life, and according to Munson (1912) they are not uncommon in policemen, letter carriers, and soldiers. The fifteen patients in subgroup A ("painful heel") presented with pain and tenderness beneath and at the sides of the heel. The pain was aggravated by marching or stamping the heel on the ground as in coming to attention or standing at ease, and the left heel, which is stamped in these manœuvres, was more often involved. There was no bruising or positive X-ray findings in any of these patients, and only three had any history of injury, such as falling on to the heel. Some of them recovered without loss of training time, but the majority of the soldiers needed to rest the heel for a few days. All except one were back in full training within seven days. One patient took six weeks before eventual recovery, but he was "sick on leave" for part of this time. There were no examples of the chronic refractory type of painful heel, variously attributed to neurosis, fibrositis, Dercum's disease, etc. (Cozen, 1939 ; Tower, 1938). The underlying pathology of painful heel is believed to be a mild traumatic periostitis. The fibro-fatty pad and the overlying callous skin have not had time to respond to the excessive "hammering" of the heel with increased thickness and density, and the buffering mechanism is inefficient (Tower, 1938). Ashley (1939) and Kuhns (1949) give a detailed description of this fibro-fatty cushion and its reaction to injury and disease.

Trauma, therefore, appeared to play the major part in the production of

foot ailments in these infantry recruits. In subgroup C the trauma or strain was direct and sudden, but in subgroups A, B and D the action of the stresses and strains which are associated with infantry training, upon structures which have not had time to become adapted to them, was held to be responsible. In spite of the efficient measures to exclude recruits with foot defects and to maintain a high standard of boot fitting and of foot and sock hygiene, 11 per cent. of these recruits developed foot complaints during their basic training. This constitutes an important problem and it must be much more serious in units where the preventive measures are less thorough. Further investigation, upon a bigger scale, into the incidence, causation, and prevention of foot ailments (especially those produced by trauma) in British army recruits, appears to be merited.\*

#### SUMMARY

1. A report based on the records of 623 infantry recruits during their six weeks' basic training is presented.

2. Every recruit, before being accepted for infantry training, had passed through careful medical and personnel selection procedures.

3. Throughout the period of this investigation, a high standard of boot fitting and of hygiene was maintained amongst these recruits and morale was good.

4. A total of 359 new patients was seen and 69 of these, forming easily the largest group, had foot complaints.

5. The most important subgroups of foot ailments, numerically, were blistered and sore feet, injuries due to direct and sudden trauma or sudden strain, and painful conditions of the heel.

6. The implications of these findings are discussed.

It is a pleasure to express my gratitude to the Commanding Officer and staff of the Regimental Depot, The Green Howards, for their helpful co-operation; to Mr. R. P. Jepson, F.R.C.S., for his helpful suggestions; and to the Director of Army Health and the Superintendent, A.O.R.G., for permission to publish this paper.

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\* It is understood that since this paper was received for publication such an investigation has been begun.—ED.

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## A SHORT HISTORY OF THE DEVELOPMENT OF THE ARMY EMERGENCY RESERVE, THE TERRITORIAL ARMY AND THEIR MEDICAL SERVICES

BY

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(Continued from page 24, January issue)

### MEDICAL SERVICES OF THE MILITIA

In the Crimean War, medical officers of the Militia, on embodiment, carried out their work in exactly the same way as Regular medical officers, *i.e.*, working in the small water-tight compartments of the regimental hospitals with no facilities for evacuation of the wounded. Little recognition was given for their services. Evidence given before a commission held in November, 1888, shows that these surgeons, at the end of the war, represented to the House of Commons that they should either be permanently employed or compensated for their loss of practice. The Government took swift and effective action in response to such a reasonable request and ceased to appoint surgeons to Militia regiments!

The Territorial and Auxiliary Forces Act of 1907 sanctioned the split which had already taken place between the medical services of the Militia on the one hand and those of the Volunteers and Yeomanry on the other. By this Act and by Army Order 271 of 1908 it was decided, among many other enactments, to create :

- (a) A Special Reserve of Officers for the R.A.M.C. under conditions similar to those of the Army Reserve of Officers.

- (b) A Special Reserve of other ranks on a Militia basis to be employed for general service with the Regular R.A.M.C. on the outbreak of war.

By the same Act, the creation of a Territorial Force Medical Service "similar in organization to that of the Regular R.A.M.C." gave much greater encouragement for volunteers to join the newly formed Territorial Force than the Special Reserve. In fact, when in 1909 and 1910 officers of the Director-General's Staff visited the Universities of the United Kingdom to urge medical students to join the Special Reserve and Territorial Force after qualification, they received little response as regards the Special Reserve but a most gratifying one as regards the Territorial Force. A further impetus to recruiting was given by the formation of medical units of Senior Officers Training Corps at the Universities. The basis of training was that of a field ambulance. Oxford, Cambridge and Edinburgh formed medical units in 1908, London in 1909, Dublin and Belfast in 1910 and Aberdeen in 1912. The cadets were trained with a view to taking commissions in the Regular Army, the Special Reserve or the Territorial Force. Although the Regular Army and the Territorial Force benefited greatly from this scheme, recruiting for the Special Reserve was meagre. By June, 1914, the medical officers of the Special Reserve numbered only 248 and the other ranks 1,435.

It is stated, however, that 45 per cent. of the regimental medical officers who took part in the Battle of Mons in 1915 were Special Reserve officers who, despite their lack of preliminary training, acquitted themselves well.

Incidentally, the Dublin University O.T.C. with its medical unit can be the only O.T.C. in the Kingdom which came under fire on its own ground. This is due to the fact that it took part in the defence of Trinity College during the Easter Rebellion of 1916.

By the 1921 Territorial Army and Militia Act the Special Reserve was renamed the Supplementary Reserve, but again the Supplementary Reserve R.A.M.C. had no corporate existence and was largely continued for the provision of battle replacements in the Regular R.A.M.C. Such a role had little appeal to keen volunteers, with consequent benefit to the recruiting figures of the newly formed Territorial Army. In fact, the Army List of July, 1925, shows that the Supplementary Reserve had at that time only five R.A.M.C. officers. This number had grown to a modest 33 by December, 1938. At the same time the other ranks numbered 1,053.

The serious shortage both of medical officers and other ranks prompted the taking of special steps to increase recruitment into the Supplementary Reserve, and during the next six months more than one hundred doctors joined. At the outbreak of war the strength of other ranks Supplementary Reserve was 1,404.

The pattern has changed again since the late 1940's. With the over-subscription of Territorial Army medical units, due to the influx of National Service officers and men, the Army Emergency Reserve is expanding. It now has general hospitals, field ambulances, casualty clearing stations and other medical

units as well. Composed largely of National Service officers and men completing their part-time engagement, but also of a sprinkling of volunteers, these units, although unfortunately they cannot train all year round like Territorial Army units, can at least achieve some sense of cohesion and solidarity during their fortnight's annual camp.

#### THE MEDICAL SERVICES OF THE VOLUNTEERS

The Volunteer movement began in 1859 largely as detached companies of riflemen, to each of which a local doctor was attached. Battalions were formed as administrative units in 1863 and each battalion had its surgeon and assistant surgeon. By 1871 the territorial aspect of these battalions was beginning to emerge by reason of their attachment to Regular regiments, which were themselves being organized on a territorial, *i.e.*, geographical, basis. By 1881 Volunteer infantry brigades were formed and with them evolved brigade surgeons.

About this time, Mr. (later Sir) James Cantlie, an assistant surgeon at Charing Cross Hospital, began to interest himself keenly in first aid and the stretcher drill of the Volunteers. This stretcher drill had been originated by a serjeant of the London Scottish, Mr. Andrew Maclure, and Maclure's enthusiasm in connection with the Volunteer battalions communicated itself to Cantlie.

Volunteer medical officers in the early 1880's wore the uniform of the regiment to which they were attached, and the only transport for the sick were the regimental stretcher-bearers. Maclure wanted to collect men trained in stretcher drill from all the different Volunteer battalions and form them into a unified, corporate body, all wearing the same uniform and under the orders of their own officers and not under those of the regimental commanding officers.

Cantlie seized upon this idea with enthusiasm and was soon joined by Surgeon Major Evatt, whose mind was working along the same lines. Between them they laid the foundations of the Volunteer Medical Staff Corps. In 1884 a deputation, consisting of representatives of the Volunteer surgeons, the Civil Medical Schools and members of ambulance associations, called upon the Secretary of State for War and put forward their suggestions for the formation of a Medical Staff Corps for Volunteers which would furnish a trained reserve in war. On 1st April, 1885, the Volunteer Medical Staff Corps was gazetted with Cantlie as its first Surgeon-Commandant, and in August of the same year went to Aldershot for its annual training, where it was warmly received by its Regular brethren. This was the first organization to unite medical officers and men in the same corps, for at this time the Army Medical Department and the Medical Staff Corps were still separate. In 1902 the Volunteer Medical Staff Corps became the R.A.M.C. Volunteers.

A fascinating publication entitled "Manual for the Volunteer Medical Service" was produced in 1892 by Surgeon-Captain Reginald Sleman of the Army Medical Reserve of Officers and 20th Middlesex Artists Rifles Volunteers. In Section I he outlines the constitution of the whole Volunteer Force, states that a bearer company is allotted to each infantry brigade and gives the estab-

lishment of the bearer company. The bearer company was commanded by a Lieutenant-Colonel and had 3 other officers, 2 staff-serjeants, 1 bugler and 53 rank and file. All the officers and the Serjeant-Major (the senior staff-serjeant) were mounted.

Quotations from this pamphlet would take up far too much space, but titles of successive sections are : "Capitation Grant and Conditions of Efficiency and Proficiency ; Army Medical Reserve of Officers ; Medical Officers of Yeomanry Cavalry ; The Volunteer Medical Staff Corps ; Schools of Instruction ; Duties in Camps, Barracks and on the Line of March ; Hospitals in Camp ; Medical Personnel and Equipment of a Battalion ; Discipline ; Compliments and Salutes ; Uniform ; Medals and Decorations ; Presentation at Court ; Mess." Appendices deal with the Correct Method of Correspondence and name the Staff of the Volunteer Ambulance School of Instruction, whose President was Major Andrew Maclure, late London Scottish, whom we first met as a serjeant in 1883. There is much in the latter part of this pamphlet that could be read with advantage and taken to heart by many officers today.

A pamphlet published by Evatt in 1904, entitled "Suggestions for the Improved Organization of the Medical Services of the Volunteer Forces," also makes fascinating reading. The following are only some of the numerous suggestions which he made :

(a) *A Students' Corps*.—A cadet battalion, solely composed of students of medicine, to be formed in London and cadet companies at Manchester, Edinburgh and Aberdeen ; to be quite separate from the R.A.M.C. Volunteers ; to have a special adjutant and chosen instructors ; a full capitation grant to be allowed ; a distinctive uniform to be granted ; ambulance equipment to be given. Fourteen days' training and lectures annually at camps to be the rule, etc. etc.

(b) *County R.A.M.C. Volunteer Corps*.—In every county all existing volunteer medical officers of all corps and branches to be placed on one list as a county battalion, to be graded into ranks. All regiments and corps to be supplied with medical officers from this corps and all field hospitals and bearer companies also. An adjutant R.A.M.C. to be supplied for the corps in certain cases ; serjeant-instructors also and allowances as for a corps. All companies of R.A.M.C. Volunteers in the county to be part and parcel of this corps, to which a section of pharmacists, clerks and, if necessary, a nursing section be added.

(c) A staff officer at the Headquarter Medical Division, War Office, to be appointed for Volunteer and Reserve Forces.

(e) The regimental aid of the battalion to be increased to two medical officers, one serjeant of R.A.M.C. Volunteers and at least eight privates and non-commissioned officers of the same corps.

(f) The bearer company to be called Field Ambulance and to consist of six medical officers, one quartermaster and at least 100 non-commissioned officers and men.

(h) Formation of a reserve for war of medical officers.

(i and n) Rewards and distinctions to be available to Volunteer officers.

Evatt was a profuse and doughty pamphleteer who initiated many reforming crusades. His sole object was the advancement of the prestige and efficiency of the Corps, whether Regular or Volunteer, and it is remarkable both how broad his vision and outlook were and how many of his numerous recommendations were ultimately adopted.

The Territorial and Reserve Forces Act of 1907, implemented by Army Order 271 of 1908, decided upon :

"The formation of the Territorial Force R.A.M.C. similar in organization to that of the Regular R.A.M.C. with medical and sanitary personnel for regiments, field ambulances and cavalry field ambulances, stationary and general hospitals, sanitary units and administrative medical staffs for service in connection with home defence."

Thus the Territorial Army as we know it today was born and the skill with which the accouchement was performed, together with the meticulous ante-natal care which had been lavished upon it, ensured that a lusty baby grew up into a healthy and powerful adult, rapidly outstripping its more puny and sickly brother, the Supplementary Reserve.

The patriotism and foresight of Lord Haldane had no finer justification than in the achievements of the Territorial Force in the First World War. The Army List of July, 1914, shows that the Territorial Force had, in addition to regimental medical officers, 14 mounted brigade field ambulances, 42 field ambulances, 23 general hospitals, skeleton staffs for 14 clearing hospitals and two sanitary companies.

Mobilization of the Territorial Force Medical Services was carried out smoothly and expeditiously. The Territorial Force field ambulances existed as complete units, each combatant unit had its own medical officers and the general hospitals had cadres of two officers, a quartermaster and a large *à la suite* establishment of medical officers.

On mobilization, the field ambulances and regimental medical officers were ready immediately and 23 general hospitals by the end of August, 1914. By May, 1915, 25 general hospitals were at work in the United Kingdom. Territorial divisions which went overseas took their own field ambulances with them, and in 1917 general hospitals were formed to go overseas. The original general hospitals were organized on an establishment of 520 beds, but many of them quickly expanded. For example, the 2nd Western General Hospital in Manchester grew to such an extent that in 1917 it had 6,700 beds. Altogether, Territorial Force hospitals expanded from an original bed establishment of 11,960 to one of 48,234 in 1917.

Not until 1918, however, was a committee set up to inquire into the staffing of medical establishments in the United Kingdom in relation to the numbers employed and their distribution. A special subject of inquiry was those officers of high local standing known as *à la suite* officers. These gentlemen held commissions, generally of high rank, in their local Territorial hospitals, but were

permitted to carry on their full civilian hospital appointments and consulting practice as well. They were, in fact, only part-time officers who, while enjoying the prestige of senior Army rank, suffered neither the rigours of active service nor the even more painful deprivation of their considerable private practices. This eventually caused a scandal in the profession, but the war came to an end before the recommendations of the committee could be enforced.

Official figures for the R.A.M.C. (T.F.) strength during the war are as follows :

<i>Date</i>	<i>Officers</i>	<i>Other Ranks</i>
August, 1914	1,889	12,520
„ 1915	6,230	?
„ 1916	3,300	40,500
„ 1917	3,130	33,000
„ 1918	2,885	30,000

The fall in numbers subsequent to 1915 is due to the fact that after the passage of the Military Service Act in 1916, recruiting for the Territorial Force ceased and recruiting for the whole R.A.M.C. was adopted instead. In addition, Territorial officers and men became available for posting where required.

The Military Service Act brought about conscription despite the efforts of Lord Derby who, when Director-General of Recruiting in 1915, instituted a system of group recruiting by which men could attest and be transferred forthwith to the Reserve, to be called up as and when their services were required. When it was found in 1916 that large numbers of single men of military age had not become "Derby Recruits" the Military Service Act was introduced.

In consequence of this Act and its provisions, third-line mounted brigade field ambulances were disbanded in November, 1916, and posted to the Regular R.A.M.C. training centres. In February, 1917, nine second-line and two third-line field ambulances were disbanded, while in March, 1917, all third-line units and depots were abolished and transferred as training companies to the R.A.M.C. training centres at Blackpool. These companies later provided drafts for Territorial Force units overseas.

When the armistice came in November, 1918, there was at first a six to nine months' delay before adequate plans for demobilization were put into practice. This caused so much dissatisfaction that the reverse occurred ; demobilization took place rapidly, and by 1920 the Territorial Force R.A.M.C. was practically non-existent.

A fresh chapter, however, came to be written after the passage of the Territorial Army and Militia Act in 1921 when the Territorial Force was re-formed as the Territorial Army.

In the gay, early post-war years little thought was given to voluntary army service and, in addition, by the time the 1930's were reached, Great Britain was affected to some extent by the disastrous American slump in 1929. This



was a period when recruiting was at its lowest ebb. Commanding officers of Territorial Army units and their company commanders, anxious to keep their units' heads above water numerically, were willing to search the hedgerows and by-ways for recruits and pleaded with their medical officers or civilian medical practitioners to pass into the unit the halt, the maimed and the blind. This stricture, however, does not apply to medical units.

The medical officers who were complaisant enough to fall in with their Commanding Officers' suggestions laid the foundations of much future work and trouble, not only for themselves but for many others as well. By 1939-1940 Anti-Aircraft Command had grown into an enormous organization, composed almost entirely of Territorial units. Many Regular and Territorial officers will remember the hundreds of medical boards which were held up and down the country for the sole purpose of ridding Anti-Aircraft Command as quickly as possible of the bed-wetters, the myocardial menaces, the neurotic nuisances, the orthopædic oddities, the tabetic totterers and the like who were cluttering up units and rendering them practically non-operational.

The embryo of what was later to become A.A. Command was formed on 15th December, 1935, by the constitution of the 1st A.A. Division to cover London and the Home Counties. On 10th December, 1936, 2nd A.A. Division was formed for the defence of the large midland cities. The continued transformation of Territorial infantry regiments into A.A. units led to the formation of five divisions by 1st April, 1939, and these five divisions became A.A. Command on that date.

6th and 7th A.A. Divisions became operational on 4th December, 1939, and by 1941 there were in all twelve A.A. divisions. Each searchlight and gun regiment had respectively three and two medical officers, each brigade had a S.M.O. and each division had its A.D.M.S. and D.A.D.M.S. At the head was the D.D.M.S., A.A. Command, who had with him at Command an A.D.M.S. and a D.A.D.M.S. All these officers were Territorials.

At the end of 1942 A.A. Command was reorganized to conform more easily to the pattern of Fighter Command and the twelve divisions were reduced to seven groups, with the consequent release for other duties of five A.Ds.M.S. with their D.A.Ds.M.S.

During the inter-war period the R.A.M.C. Territorial Army field force, in common with the rest of the Territorial Army, was suffering varying vicissitudes. The provisional peace-time establishment for the R.A.M.C. was in 1920 :

Field Ambulances	...	...	...	...	...	45
Casualty Clearing Stations	...	...	...	...	...	15
General Hospitals	...	...	...	...	...	23
Sanitary Companies	...	...	...	...	...	4
Schools of Instruction	...	...	...	...	...	14

Owing to the necessity for stringent financial retrenchment, this establishment was severely pruned both in 1922 and 1927, and in the latter year the new establishment was as follows :

Medical Services for Divisional H.Q.	...	...	14
Field Ambulances	...	...	14
Cavalry Field Ambulances	...	...	1
General Hospitals	...	...	3
Hygiene Companies	...	...	4

It was not until 1936 that the War Office accepted in principle the representations of the Army Medical Directorate that three field ambulances and not one were required to supply the medical needs of a division.

In 1938 the whole Territorial Army field force was reorganized with the consequent reorganization of the R.A.M.C. component. A further alteration took place in 1939.

In August, 1939, the medical units of the Territorial Army were as follows :

Field Ambulances	...	...	...	...	34
Cavalry Field Ambulances	...	...	...	...	4
Field Hygiene Sections	...	...	...	...	15
Casualty Clearing Stations	...	...	...	...	4
General Hospitals	...	...	...	...	15

In addition to these purely medical units, all the combatant units of the Territorial Army had their own regimental medical officers.

Following the outbreak of war no further recruitment was made into the Territorial Army as such, as it had become embodied in the Regular Army.

Between the outbreak of war and June, 1940, some 3,000 doctors volunteered for commissions in the R.A.M.C. It had, however, become apparent that the future need for medical officers would greatly exceed the number of volunteers, and accordingly in June, 1940, medicine was removed from the schedule of reserved occupations. In consequence, medical men became liable for compulsory military service under the terms of the National Service (Armed Forces) Act, and to this day conscription for doctors is still in force, though in a modified form.

In 1947 recruiting began again and many volunteers came forward. The Territorial Army had now, however, lost its purely voluntary aspect, its numbers henceforward being largely made up of National Service men. At the present moment the R.A.M.C. is well represented with general hospitals, field ambulances, casualty clearing stations, a field hygiene company and other units as well.

#### CONCLUSION

The patterns of service in the Army Emergency Reserve and Territorial Army have been traced since their earliest days and it has been seen how they have changed in answer to the pressure of national and international events. It would appear, as has recently been forecast by the military correspondent of *The Times*, that the present pattern as regards voluntary service must soon be due for further consideration. The volunteer element both in the Army Emergency Reserve and Territorial Army is unfortunately decreasing as the

numbers who perforce must retire on account of age are scarcely being balanced by new volunteers. In addition, the burden which is now thrown upon the volunteer officers, warrant officers and senior non-commissioned officers is a heavy one, and many because of their civilian commitments cannot or will not accept it for long. Some new system must be evolved if the long and honourable record of voluntary service in the Reserve and Auxiliary forces of the Crown does not eventually reach its *Götterdämmerung*.

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## DUNDEE DOCTORS IN WAR TIME

BY

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THE title of this paper embraces three things in which I have for long been interested : my native town, my profession, and the army medical services. But I am not going to indulge in personal reminiscence, my

“plaintive numbers flow  
For old unhappy far off things  
And battles long ago.”

In the earliest days of which we have records in Dundee, when the town was only about one mile long by about half a mile wide, one had usually not far to go to find the enemy ; he might be on one's doorstep or even in the house, and, if wounded, one called in one's own doctor. The first record we have of such attention is in 1550, when Robert Pypar, a well-known barber-surgeon of the time, sued Gibbe Saidler “for the curing of Riche Saidler's heid hurt be ynglismen” apparently in the capture of the town in 1547. The balance due was about 7s. 6d.

But by this time some attempt was being made to provide medical attention for Scottish troops. Comrie (1932) says that the first reference to military surgeons in Scotland is in the Register of the Privy Seal of Scotland of 1542, which notes disbursements to five surgeons on account of services to Mary of Guise, regent to Mary Queen of Scots, apparently in connection with military operations in the Borders that year. In 1560 a contingent which set out from Dundee under Provost Haliburton to help fight the French troops brought over by the Queen Regent was accompanied by local surgeons whose pay had been guaranteed by the Earl of Moray. In 1567, however, James Carrail, another Dundee barber-surgeon, asked testimony of the Magistrates that they had never been paid as promised for their “grite labours and costs upon curing and healing of Inglismen and Scottismen there hurt and wounded” ; that is at the siege of Leith, where, for once, Scots and English were on the same side. I don't know if they were ever paid.

Such references are very tantalizing in their brevity ; one would like to know so much more about the tales they could tell. For instance, on 8th April, 1615, James Neill, surgeon, was made a burgess of Dundee “for his services in curing the inhabitants of the Burgh who were wounded in the service of the Country, and for his attendance upon the poor of the said Burgh, when requested by the Provost and Bailies.” This, says Millar (1887), is the earliest instance of any

recognition of gratuitous medical services recorded in the civic annals. James does not appear anywhere else in the records of Dundee. No clue to his life and career has been found ; nor is it easy to say in which war the casualties occurred. And so we must leave him.

Dundee's greatest tragedy was the storm and sack of the town by General Monk in 1651. I cannot give any medical details of this tragic episode, but I may be permitted a digression from my strict theme in dealing with the Cromwellian war. Anna, wife of Sir James Halket, Bart., of Pitfearne in Fife, had an unusually high education for a woman of this time. The Duke of Gloucester and Princess Elizabeth, children of Charles I, were her pupils. Besides being deeply religious and a student of theology, she had from her early years studied "physick" that she might be able to help the poor, and she gained a considerable reputation. After the battle of Dunbar in 1650 she set out with her companions and necessary equipment to do what she could to help, and, coming to Kinross, "she and her women dressed about thrie score poor wounded soldiers" they found there. This is the earliest record I can find, at least as far as Scotland is concerned, of a women's voluntary aid detachment, and deserves more recognition than it has gained.

Patrick Blair, M.D., F.R.S., was born in Dundee about 1666. Less than justice has been done to his memory. He published works on natural history, botany and medicine. He was the first to dissect an elephant in this country, he was the first to give in English a reasoned and convincing proof of sex in plants, and he was the first to describe the symptoms of pyloric stenosis. He started his professional life as a surgeon-apothecary and apparently served with the Army in the Low Countries, for in his writings he refers to surgical and medical cases he had dealt with there during the years 1695-1697. Soon after this he settled in Dundee and made his presence felt in his native town, but in 1715 he joined the Jacobite army, though he afterwards said he "was in no respect accessary to the late troubles, but happening to reside near the parts where the rebellion broke out, the gentry forced him to accompany the army as a medical attendant." He missed the battle of Sheriffmuir, was made prisoner at the surrender at Preston, took part in the miserable trek in bleak November weather across the Midlands to London, where he found himself in Newgate, a condemned rebel. He had previously become a firm friend of Sir Hans Sloane and Petiver, the apothecary, and they did their best to get him a reprieve, but on the eve of his execution it had not arrived. Petiver visited him that evening and, writing to Sloane, tells how "the doctor sat pretty quietly till the clock struck *nine*, and then he got up and walked about the room ; at *ten* he quickened his pace ; and at *twelve*, no reprieve coming, he cried out 'by my troth, this is carrying the jest too far.' " However, it arrived soon after and finally Blair was pardoned. He did not return to Dundee, but ended his days in Boston in Lincolnshire practising medicine and writing about botany.

As to the '45, there is no record of a Dundee doctor serving on either side, but a near neighbour, Sir Stuart Thriepland of Fingask, half-way between Dundee and Perth, was an enthusiastic Jacobite and became principal medical

adviser to the Prince. He had taken his M.D. degree at Edinburgh in 1742 and became F.R.C.P.Ed. in 1744. He took part in the march to Derby, was present at Culloden and attended the Prince in the early part of his wanderings. He looked after Lochiel, who had been seriously wounded in the battle, in a cave on Ben Alder. His patient recovered. He joined Prince Charles in Paris, but returned to Scotland in 1747 under the Act of Indemnity, settled in Edinburgh, where he practised, and died in his ancestral home in 1805. His travelling medicine chest, usually known as "Prince Charlie's medicine chest," is preserved in the Royal College of Physicians in Edinburgh.

The Napoleonic wars were fought by regular troops, but the volunteer movement was strong throughout the country, and these auxiliary troops not only acted in local defence against invasion but some had more onerous duties assigned to them. The 1st Regiment of Dundee Volunteers (Loyal Tay Fencibles) was sent to Ireland during the rebellion of 1798, and Dr. Alexander Bell as Surgeon and Lieutenant accompanied it. When the regiment was disbanded in 1802, Capt. Bell, as he then was, was presented with "an elegant silver cup by the members of his company as a token of their regard for him during the five years they were under his command." He settled in Dundee, where for many years he had an "extensive and lucrative practice."

At least two Dundee doctors went to the Crimean War. Dr. James A. Cowper, son of the parish minister of Glamis, was appointed first surgeon of the 7th Regiment of the Turkish Contingent. He wrote many interesting letters home which have been lost, but probably would have told us little of the campaign, for, an account of him says, "the warlike operations were carried on at places a distance from those at which Dr. Cowper was stationed, with the exception of one affair, in which a Russian captain was killed; so that he had not much opportunity of witnessing the sanguinary scenes with which this war abounded, or of exercising his professional skill for the relief of the wounded." The Turkish Government, however, gave him a medal for his services, and in 1856 he settled in practice in Dundee and became its first "public officer of health." He was also medical officer of the Highland Company of the Dundee Rifle Volunteer Corps, and died of typhus, a common fate of doctors in those days, in 1866, aged 40.

One could say much, on the other hand, of Dr. David Greig's Crimean experiences. His letters home have been carefully preserved by his family and, thanks to the kindness of his daughter, Mrs. Annette Stewart of Glengarden, I have been privileged to see a typescript of them extending to some 200 quarto pages. David Greig, son of a Dundee doctor, was born in 1831 and qualified in Edinburgh. "My great object," he says, "in joining the army was in these active times, in the first place to get surgical practice, to see the world, to get the *eclat* of being at the war, and to get a year or two's recreation before settling in practice." Before he set off in October, 1854, he received a charming letter from his old teacher, Sir James Simpson, wishing him God-speed. Simpson told him that Lord Blantyre wished him to take chloroform out. "They have not nearly enough there and I hope you will be able to show them how to use

it properly." He also asked Greig to write to him about his experiences, to take notes of the diseases as well as the wounds, as an excellent medico-surgical essay could be written on the campaign.

Greig sailed in the *Vectis* from Marseilles. "What a cargo we have, it consists of 18 doctors . . . 48 nurses . . . Protestant, Episcopalians and Catholics, Sisters of Mercy, nurses from the London Hospital, etc. I do pity them during the voyage, they are all so sick. When they get to Scutari or wherever they go, some ladies are among them—even ladies of fortune and title—they will I am sure soon tire of their good works." Greig did not then know that Florence Nightingale was amongst the "cargo," but, as he was posted to Scutari barracks on his arrival, he soon came to know her. One realizes how quickly she made her presence felt, for on 30th December, less than two months after they had landed, Greig wrote to his sister: "You asked me by the bye about Miss Nightingale—when on board the *Vectis* I did not know who or what she was, but since then we all know her very well. She is a very kind lady and what is more has £8,000 a year which we all joke about here. The nurses are all under her charge, sometimes we get a visit from her in the wards and if a nurse is required for a patient she sends one. At some parts of the hospital they attend every day and dress the patients, but to do that at all the hospitals would require 50 times the number. She keeps strict watch over them and they work very well, but I think the same could be done by the orderlies which we always have in our wards."

Greig was very jealous of the honour of the medical service, and later from Sebastopol he wrote to his sister, very angry with the writer of a letter to *The Times* about neglect of the wounded, in June, 1855. "He says he could not get drinking cups, water, food, splints, etc. Why? because he was an ass, and did not know where to get them as he should have done. I have never yet applied in vain for anything which would be of use to my patients even to calf's foot jelly, lemon jelly, soups, turtle soup or even champagne. Everything can be got if you go rightly about it."

He was very proud of one of his surgical experiences as he tells his father. He had been transferred to Kulalie in January, 1855, where he looked after Russian prisoners ("some are very badly wounded, more especially the Cossacks who were engaged in the cavalry charge at Balaclava and who have got some very ugly cuts especially about the back of the head") as well as English sick. The surgeon in charge asked his opinion of a man of the 30th Regiment who had been sent down from the Crimea with frost-bitten feet. "I told him he ought to amputate one of the feet at the ankle after Syme's method." (Syme had been another of Greig's teachers in Edinburgh.) "He said he would rather amputate below the knee as he was not acquainted with that operation, having been all his days at the Cape of Good Hope. I took him to the dead house and showed him how to do it. He said 'My fine fellow, it is a beautiful operation but I can't do it; if you like to take the risk and say it should be done, you must do it.' Just what I wanted. We had a consultation of all the staff and everyone spoke against it, but as I insisted on it the patient was taken from a fellow senior to me

in the service, put in one of my wards, the operation performed and I am glad to say I have saved a nice young fellow's leg, besides getting a good deal of credit from all my companions, and the result is all the bad cases are sent to me, which is very good. The amount of practice I see here of all kinds is immense and I hope may be of use to me in after life."

Soon after this, in February, 1855, Greig developed what was evidently typhoid fever and nearly died. He had already been pulling strings to get to the Crimea, preferring as he said, "the hardships of the camp to the dangers of an hospital," and after his recovery, reached the British Base at Balaklava in April. Here he received an "immediate" order attaching him to the 17th Regiment before Sebastopol. "I knew what 'immediate' meant so I took my time and yesterday forenoon I got my luggage upon one pony and myself upon another and set off for camp." His experiences of active service in the field are very like those of more recent wars. He did his duty, not without its attendant difficulties and dangers, and had narrow escapes. On one occasion he wrote: "When I was buried by that round shot my only feeling was 'well the day of judgment can't be much worse than this.'" On another occasion, doing duty in the trenches, he wrote of a bombardment: "The first shot they fired came slap thro' an embrasure close to me, caught one poor fellow in the face, took his head off, wounded another and dashed into a powder magazine close by sending the stones flying in all directions. I attended to the wounded man as well as I could considering the state I was in. I then went to look at the one that had been killed. The whole of his head had been knocked off except his right whisker." The fears of the man could not abolish the wish to observe of the doctor! "Shot and shell," he wrote, "look very well at a distance but they are anything but pleasant when they are flying about your head." A sentiment with which we can all agree. Crimean mud, according to Greig, was no different to that of more recent wars, and the strange "uniforms" which appeared in the Eighth Army in the desert were not really innovations; in the Crimea Greig's normal garb was just as much a departure from the standards of his day. He quotes a French Order of the Day which appeared after there had been considerable fighting for some rifle pits. The Allies had captured several, but the French lost theirs again. The order went: "The English have taken their rifle pits. When the English take rifle pits, they keep them. (*Signed*) CANROBERT."

Lighter things occupied Greig's pen as much as the more serious. Soldier servants have changed little; good friends they can be, but they have their foibles. When he was ill he had a servant from the 79th Highlanders. "He often put me to sleep by talking of Scotland. He was rather religiously inclined altho' very fond of whisky when he could get it." Greig and another medical officer with whom he shared a tent in the Crimea came to a very sensible arrangement. They each had a servant: "Neither of our servants are teetotallers, we give them warning that they must never get drunk at once or we will immediately have both flogged." They could look after themselves well as soldiers have always done. Greig wrote to his mother: "There is a large hole dug which is our wine cellar which we always try to keep as respectable as possible. It is the



coolest place in our tent and cold drinks are everything. I know you are very anxious to know what we have in our wine cellar, are you not ? Now confess and I will tell you. Oh, how miserably we poor fellows in the Crimea do live, fighting for an ungrateful country, just think what a miserable cellar we keep, it contains only Sherry, Marsala, Brandy, Whisky, Rum and home-brewed lemonade. No wonder we look thin !!!” His account of a dinner in the field with his Brigadier makes one’s mouth water. He had hiccups all night after and evidently deserved it !

Routine duties took up part of his time, such as weekly inspections to see all men were clean ; feet, legs, hands and arms were all looked at and if necessary the men had to strip. “If a man has dirty feet he gets extra drill, is sent to the river to wash them and if he is very bad he may even be flogged.”

After Sebastopol was captured Greig was appointed in December, 1855, to one of the newly formed Pathological Boards, work which evidently suited him. He got the job, he considered, through Dr. Guthrie, for whom he had made a few preparations and written a paper on gunshot fractures of the femur. In March, 1856, he wrote that though his board had 27,000 men under its charge only 22 deaths had occurred during the previous month, and he thought it would be even less that month. “No one could wish the British Army in better condition. The French are however very sickly.”

But now the war was over and in July Greig left for home and took up practice in Dundee in December, 1856. He kept up his military interest by becoming surgeon to the 1st Forfar Company of the Dundee Rifle Volunteers, and ran a busy practice, including several public appointments, till his death in 1890.

These glimpses of our predecessors show that our own experiences are not novel. They too, when danger threatened their country and homes, were ready to devote their services to the army, and in spite of recent discoveries an army doctor’s duties and experiences, like the principles of war, do not change.

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# HAND WOUND WITH UNUSUAL BACTERIAL FLORA

BY

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THE occurrence of normal commensals of the upper respiratory tract in a suppurating wound of the hand is sufficiently unusual to be worth recording.

## CASE HISTORY

A young soldier was admitted to hospital late one night with a deep wound of the dorsum of his right hand, caused, he said, by a fall. (On subsequent questioning, the patient revealed that he had been involved in a fight, during the course of which he had struck his opponent in the mouth and received a bite.) The wound appeared clean at the time and was therefore primarily sutured. The patient was put on systemic penicillin as a precaution.

In spite of this, during the course of the next three days the patient's temperature rose and he complained of pain in his hand, which showed œdema, redness and pus round the sutures. The sutures were removed and the pus allowed free exit.

A swab of the pus was sent to the laboratory for bacteriological investigation.

## BACTERIOLOGY

Direct smear showed numerous Gram-negative rods and cocci. The swab was cultured on blood agar and MacConkey's medium. The growth on the following day showed :

- (1) A heavy mucoid growth of a Gram-negative, non-motile, encapsulated organism, which fermented glucose, mannite, saccharose, maltose, salicin and lactose, with gas production except in lactose, glucose and salicin ; no fermentation of dulcitol ; indole reaction negative. (Friedlander's bacillus.)
- (2) A moderate growth of a Gram-negative coccus, which fermented glucose, saccharose, maltose and lactose. (*Neisseria crassus*.)
- (3) A scanty growth of a Gram-positive coccus in clusters, which failed to ferment marnitol and which gave a negative coagulase test by both slide and tube methods. (*Staphylococcus saprophyticus*.)

The sensitivity of the organisms showed :

- (1) The Friedlander bacillus was sensitive to chloromycetin, streptomycin and aureomycin, but insensitive to penicillin.
- (2) The *Neisseria crassus* was sensitive to aureomycin only.
- (3) The *Staph. saprophyticus* was sensitive to aureomycin, chloromycetin and streptomycin, but insensitive to penicillin.

As aureomycin was the only antibiotic to which all the organisms were sensitive it was suggested that he be started on a course of this drug.

#### FURTHER PROGRESS OF CASE

On aureomycin the wound rapidly healed. Slight stiffness of finger remained at time of report, but the patient was receiving physiotherapy for this.

#### COMMENT

Friedlander's bacillus is a commensal of the upper respiratory passages. It has been blamed for a small percentage of pneumonias and may occasionally be found in empyema, meningitis and otitis media. When injected subcutaneously in animals, an abscess may result. Neisseria are also commensals of the upper respiratory tract and are of low pathogenity. *Staph. saprophyticus* may also occur in the upper respiratory passages, but is also present in normal skin. Two or possibly three of the organisms of this wound could therefore have been derived from normal commensals of the upper respiratory tract. The interesting feature of this case was therefore the reproduction of a normal upper respiratory tract flora in a wound of the hand as a result of direct injection of human saliva.

I am indebted to Lieut.-Colonel A. J. N. Warrack, *M.B.E.*, M.D., A.D.P., Eastern Command, for his help in preparing this note.

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## MESSING IN MILITARY HOSPITALS

BY

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THE supervision of messing arrangements in military hospitals requires the frequent attention of a number of different individuals in order to maintain a high standard throughout all messes and wards and to keep justifiable complaints down to a minimum.

There is, however, generally no officer engaged in full-time supervision of messing arrangements in our hospitals, and there would thus appear to be a strong case for the introduction of a dietician who would take control of all cooks and supervise the issue, preparation, cooking and serving of all food.

Under our system, too, we usually find it necessary to maintain separate kitchens for other rank patients, other rank staff, sergeants, officers and nursing officers even in the smaller hospitals. This system worked well in pre-war days when Regular cooks of many years' standing were available, and R.A.M.C. hospital cooks served in every hospital. These two categories of cook have been replaced by young cooks of another corps who, although trained at their depot

to perform, under supervision, the mystics of the culinary art, often do not seem on posting to hospitals to have the will or ability to work on their own.

Changes, too, have taken place in Officers' Mess life. In the pre-war era the mess was kept going by Regulars who, having embarked on a career, were keen to ensure that the mess was properly run and supported. Unfortunately, a noticeable decline has taken place in recent years in every standard of mess life partly for reasons already mentioned. The National Service officer who now predominates in most messes finds that his pay does not go very far; and if married, as so many of them are, he may well be in financial difficulties which are accentuated by the fact that he is entitled to draw Marriage Allowance at a reduced rate. He also cannot be expected to take any long-term interest in his mess, and at times it is even difficult for him to grasp the necessity for the holding of official mess entertainments to which he is expected to contribute.

It is felt that in the future it may prove desirable, in order to raise messing standards and to cut down expenses, to reduce the scope of Officers' and Nursing Officers' Messes by holding all entertainment in the local Officers' Club or elsewhere and to centralize all unit and hospital kitchens with appropriate mess-rooms adjacent, while retaining ante-rooms and recreational rooms.

It may be of interest to see how the American Army tackle their messing problems. This they do in the following ways :

1. By the recent introduction of a new corps—the Women's Medical Specialists Corps—which provides dieticians, physiotherapists and occupational therapists. These girls receive commissions and are paid at basic Army rates. This corps may well later expand to include other technical personnel. It is under the control of the Surgeon-General. The dieticians are responsible for the supervision of cooks and for all aspects of messing administration, including ordinary and special diets. A Master Menu is produced by the Pentagon every month and is standard for the Army and Air Force, and this the dietician works to closely. She and the Quartermaster's Department work in close harmony regarding ration commodities and the purchase of extras with the cash element of the ration.

2. By having a common ration scale for both patients and staff, which enables their food to be cooked in the same kitchen, to the same menu. Special diets are, of course, prepared as required, usually in the same kitchen. A monetary allowance is provided for certain categories of patient, *e.g.*, for the tuberculous, to enable extras and amenities to be bought.

3. By centralizing messing arrangements and by thus reducing the number of kitchens in the entire unit to only one or two, it has been possible to tighten up on supervision and to raise the standard of messing. This must also result in a saving of personnel, fuel, equipment and accommodation and must simplify working conditions for the cooks. Officers and other ranks eat the same food but in different rooms, and my experience has been that the food is of a consistently high standard, although somewhat different in type from ours. The

cafeteria system is generally used in which one picks up a tray, paper serviette, cutlery, bowl of soup, main course, vegetables in separate small dishes, bread and butter, sweet course, milk or water and coffee, and then finds a place at one of many small tables at which to eat. On finishing the meal, one carries the tray, dishes and cutlery to a hatch. This system saves a great deal of time and largely eliminates the need for waiters. In some hospitals other ranks, whether up-patients or staff, use the same dining hall, phased if necessary to arrive at different times. While arrangements vary at different hospitals the principle remains the same, namely supervision, centralization and the attainment of high messing standards.

An important side effect of this system is that the keeping of the various mess accounts and their auditing is entirely dispensed with, as each officer and nursing officer, who receives a monthly subsistence allowance of about £15, pays cash for each meal on entering the dining-room, and signs his or her name. The cash is collected by a N.C.O. and is handed to the Quartermaster's Department together with the nominal roll. The cash or that portion of it which relates to the cost of the part-ration is returned to Army funds.

It should be added that the majority of cooks in static hospitals are civilians and only a few military cooks appear to be employed.

#### CONCLUSION

It is considered that there is a definite need for the introduction of dieticians on a full-time basis to our hospitals. This has, of course, long been the practice in civil hospitals. The American Army has recently introduced them into its hospitals with beneficial results, perhaps the most important being the achievement of a high standard of messing.

The scheme as outlined above for the centralization of messing resources leads to easier supervision whether a dietician is employed or not, and would result in a considerable saving of coal and other commodities if adopted on a large scale throughout the Army.

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# PENICILLIN IN THE TREATMENT OF CHANCROIDAL BUBO

BY

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[The purpose of this paper is to describe fourteen cases of chancroid with fluctuant buboes, treated with penicillin at the Special Treatment (Tenno) Wing, British Commonwealth General Hospital, Kure, Japan, in January, 1952.]

## INTRODUCTION

CHANCROID encountered in this area presented as multiple penile sores with, in many cases, a large painful unilateral fluctuant bubo. It was at this time customary to treat such cases with sulphonamides and repeated aspiration of the bubo. It was found that in an analysis of approximately one hundred cases of chancroid with fluctuant buboes, none was required to be kept in hospital for less than four weeks, and many were kept for as long as five to six weeks. Even when treatment was modified by the use of bubo lavage with mercuriochrome, the length of stay in hospital was not significantly shortened. In an attempt to discover some method of reducing the time spent in hospital, it was decided to investigate the effect of penicillin in the condition.

There is conflicting opinion as to the efficacy of penicillin in chancroid. McElligott (1950) and McLachlan (1951) state that it is ineffective. Combes (1945) quotes Canizares as having observed the worsening of lesions following systemic administration of penicillin. Studies *in vitro* by Jennings (1949) indicate that *Hæmophilus ducreyi* is sensitive to penicillin in a concentration of from 0.075 to 0.25 units/ml. Further, there is of course the danger of masking a concomitant *Treponema pallidum* infection.

## INVESTIGATION

In view of the possibility that the bubo might at least in part be caused by secondary organisms, material from a number of buboes was aspirated under sterile conditions and staphylococci grown from several. These were found to be penicillin-sensitive.

### *Clinical Material and Treatment*

Fourteen cases were selected. Each had multiple chancroidal lesions of the penis and an accompanying fluctuant bubo causing severe discomfort in walking. They were admitted to hospital and confined to bed. Sulphonamide (2 g. *stat.*, 1 g. four-hourly to a total of 32 g.) was given, and saline soaks applied to the penile sores until dark-ground examination of the serum from the sores was found to be negative for *Treponema pallidum* on three separate occasions. A Ducrey intradermal test was performed on each patient. In every case the result

was positive. As soon as these investigations were completed (*i.e.*, about the third day) a single injection of penicillin was administered directly into the centre of the bubo. In half the cases the injection consisted of 200,000 units of crystalline penicillin dissolved in 1 c.c. of sterile distilled water, and the other half, 300,000 units of procaine penicillin.

### *Results*

In every case there was very rapid relief of pain, and the patient was able to get up and walk about within several hours of receiving the injection. The bubo had diminished markedly by the next day, and no sinus formation occurred. All the cases were fit for full duties on discharge by the end of ten days. The average stay in hospital was eight days.

### DISCUSSION

It is not possible to decide whether the striking results were due to the action of the penicillin on the *Hæmophilus ducreyi* or on secondary organisms. Whatever the explanation, the treatment was a great improvement. Whilst a concomitant *Treponema pallidum* infection might be affected by the injection of penicillin into the bubo, the blood level produced by the dosage employed would appear to make this unlikely. If penicillin is in fact of value in the treatment of chancroid, then an injection into the bubo has an obvious practical advantage over systemic administration. Unfortunately, it was not possible to extend the investigations any further, but the results were so striking in the small series that it was considered worth while publishing the findings.

### ACKNOWLEDGMENTS

Thanks are expressed to the Officer Commanding, British Commonwealth General Hospital, Kure, Japan, and to Sergt. Anderson, R.A.A.M.C., Cpl. (now Sergt.) G. Godbold, R.A.M.C., and Ptes. Stephenson, O'Connor, and Shaw, R.A.M.C., for their enthusiastic co-operation in the investigation. Permission to publish has been kindly granted by the Director General, Army Medical Services.

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## *Matters of Interest*

### PAPERS BY R.A.M.C. OFFICERS

- Brown, Major J. A. H. : Studies on the Antigenic Structure of Herpes Simplex Virus. *Brit. J. exp. Path.* (1953). 34, 290-299.
- Macfarlane, Colonel L. R. S., and Captain C. H. Jones : Tuberculin Sensitivity among Queen Alexandra's Royal Army Nursing Corps Recruits. *Tubercle* (1953). 34, 12.
- Naylor, G. R. E., and R. A. Caldwell : The Origin of Urinary Antibodies. *J. Hyg. (Camb.)* (1953). 51, 245-257.
- Pace, Lieut.-Colonel T. A. : L'Instruction de l'Hygiène Militaire aux Officiers du Corps de Santé de l'Armée Britannique. *Bulletin International des Services de Santé des Armées de Terre, de Mer et de l'Air*. Novembre, 1953.

### BERTRAND STEWART PRIZE ESSAY COMPETITION, 1954

The subject for this year's competition is as follows :

"For many years it has been necessary for a large proportion of the Army to be stationed in the Middle East as a strategic reserve. This has necessitated costly and extensive trooping arrangements for the relief of units and individuals and has meant that Regular officers and soldiers are often separated from their families for long periods.

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"Discuss the advantages and disadvantages of this suggestion and say whether you think it would be practicable."

The rules for the 1954 Competition were given in the July, 1953, and October, 1953, editions of *The Army Quarterly*.

## *Book Reviews*

### REPORT ON THE HEALTH OF THE ARMY, 1949-1950

Although this report, as compared with its triennial predecessor, covers the biennium 1949-1950, it is still published more than two years after the events which it records, so that it is to be hoped that in the not too distant future these reports will again become available annually.

The period under review covered the end of the post-war rundown period and the beginning of rearmament. In this time of full employment regular recruiting was not easy. During this period the Q.A.R.A.N.C. were formed, taking their officers from the Q.A.I.M.N.S. and their other ranks from nursing orderlies of the W.R.A.C., so it is now possible for such a girl to proceed to her full training as a state registered nurse. The PULHEEMS system was intro-



duced as a joint Service venture and it was soon able to prove its administrative flexibility with the outbreak of the Korean war. The drive for health education at all levels, particularly the recruit, was vigorously pursued despite the shortening of the Infantry Basic Training Syllabus. Much is being done for soldiers' families overseas, but there would appear to be a gap in the welfare provisions for O.Rs.' families below the rank of sergeant. Surely the duties of a S.S.A.F.A. nurse are rather those of a health visitor with some almoner functions than those of a district nurse? Much personnel research is also going on, with interest particularly focused on a new combat suit and the problem of load-carrying.

There are many interesting graphs of disease trends over the last half-century. Both malaria under suppressive treatment and typhoid under chlorination of water and T.A.B. immunization from being major causes of wastage have almost disappeared; sandfly fever emerges as a clinical entity about 1910 and disappears after 1945 with our Indian Empire; venereal disease decreased markedly to the outbreak of World War I, but since then there has only been a gradual decline. Do we know all the factors involved? Have we really considered the facts disclosed by the first Kinsey report? The complete absence of alcoholism after World War I is an interesting social pointer. There has been a post-war rise in tuberculosis which is partially explained by the better recognition of cases among National Service men by mass miniature radiography and the holding of cases under the long-term treatment scheme in military hospitals. On the other hand, medical invalidings are disquieting. If the excess figures for psychiatric conditions and tuberculosis are subtracted, invalidings are still at a rate of 11.19 per thousand compared with 6.12 in 1914.

It is, of course, impossible to do more than attempt to draw attention to a few of the many points in this report. But it deserves the study of all those who recognize the value of the information disclosed by statistics in the shaping of policy and in the assessment of the results of therapeutic trial.

F. G. N.

**MEDICINE.** Two vols. Edited by Hugh G. Garland, *T.D.*, *M.D.*, *F.R.C.P.*, and William Phillips, *M.D.*, *B.Sc.*, *F.R.C.P.* Foreword by F. A. E. Crew, *T.D.*, *M.D.*, *D.Sc.*, *Ph.D.*, *F.R.S.* London: Macmillan, 1953. Vol. I, pp. xx + 1077, 52 plates. Vol. II, pp. xi + 1078-2146, 71 plates. £6.

These two volumes with the impressive title, "Medicine," contain a synthesis of modern medical thought, knowledge and practice to which forty authors from England, Scotland and Wales have contributed.

The approach to the subject is a departure from that of the standard textbook and the emphasis is a modern one. This is brought out by the fact that the introduction is written by the Professor of Public Health, University of Edinburgh. Professor Crew will be familiar to Army readers both as a leading exponent of social medicine and for his services to the Army.

The table of contents is interesting. One has to go to Volume II to find the orthodox headings, "Diseases of the Digestive System," "Diseases of the Nervous System," and so on. The section headings in Volume I illustrate the

importance attached today to the study of the patient as a person, to the assessment of mental and physical health as starting points from which to measure disease, and to the background of ill-health, whether social, industrial or genetic.

This is an important work, which should be in every medical library. The price at which such a book has to be sold today makes one wonder how many copies will come into private hands.

R. J. N.

COMPRESSION ARTHRODESIS. By J. Charnley, F.R.C.S. Edinburgh: Livingstone. 1953. Pp. xi + 264. 208 illus. 42s.

A monograph for those interested in either Mr. Charnley's mechanical approach to, or his defence of compression in, the problem of arthrodesis of joints. Of all the joints he has attacked, his modification of Key's compression arthrodesis of the knee-joint is now well known, and he describes this procedure in detail. He has applied the compression principle to nearly all the joints of the limbs, details of which are given. An interesting book for orthopædic surgeons.

C. M. M.

RHEUMATIC FEVER: A SYMPOSIUM. Edited by Lewis Thomas, M.D. University of Minnesota Press, 1952. Pp. 349 (incl. 20 pp. of bibliography). Numerous photographs and figures in text. \$10.00 (80s.). London: Geoffrey Cumberlege, O.U.P.

This record of a symposium held at the University of Minnesota in 1951 contains a vast amount of information sifted and presented by a team of eminent contributors. The literary standard is higher than is usual in such a work as this, and it is refreshingly free from polysyllabic jargon. The contributions cover a very wide field and naturally vary somewhat in value and interest. Dr. George E. Murphy painstakingly conducts the reader through a labyrinthine museum of histopathology, but remains disappointingly non-committal about the interpretation of the mass of facts. Dr. Robert A. Good somehow makes immuno-chemistry both fascinating and comprehensible. Professor Charles H. Rammekamp heads the epidemiologists, much of whose work has been done in the U.S. Armed Forces and is directly relevant to problems of our own in the British Army. He and Dr. Morse J. Shapiro strongly support prophylactic chemotherapy for rheumatic patients in hospital, especially those in general wards who are liable to streptococcal cross-infection. Of the purely clinical contributions, Dr. Ann G. Kuttner's on therapy is outstanding for balanced judgment; she is not alone in preferring salicylates to cortisone or A.C.T.H. for the average case. Two statements of hers are significant: she says, "In rheumatic fever the noxious agent or mechanism has not been identified, and even the particular component of the connective tissue or cardiac muscle primarily injured has not been definitely established," and "In spite of the fact that salicylates have been used in the treatment of rheumatic fever for more than half a century, it is still not definitely known whether or not the action of these drugs is specific."

It is melancholy, yet perhaps salutary, to reflect that the huge labour and erudition represented by this book can add up to such profound ignorance of the very fundamentals of the subject to which it is devoted. The physician who reads this book will learn much, but he will return to his wards to treat his rheumatic patients very much as he has done since he qualified.

D. E. M.

**SYMPOSIUM ON FATIGUE** (The Ergonomics Research Society). Edited by W. F. Floyd and A. T. Welford. London: H. K. Lewis. 1953. Pp. viii + 196. Numerous figures. 24s.

The precise definition of "fatigue" remains "the soldier's non-military duty." That subjective state following or preceding physical or mental strain, called, for want of a better term, fatigue, remains a vague condition experienced by most but understood by no one.

This book consists of a series of papers by anatomists, physiologists and psychologists on aspects of fatigue that they have investigated and covers a wide range of factors of which climate, environment, sport, heavy manual work and motor skills are discussed. The importance of psychology in evaluating fatigue and its effects in individuals working well within their physiological limits is repeatedly stressed.

While the book is not an easy one to read straight through, any doctor connected with heavy or repetitive industrial processes will find articles well worth reading, and but for the lack of an index, this would make a good reference book as most articles are followed by a comprehensive bibliography.

J. B. M. M.

**THE MEDICAL ANNUAL, 1953.** Bristol: John Wright & Sons Ltd. Pp. 513. 27s. 6d.

The seventy-first volume of this well-known annual, edited by Sir Henry Tidy and Mr. A. Rendle Short, gives a résumé of the more important advances that have occurred in the last year. A very wide range of subjects is covered, and practically every speciality is represented. There are sections on Tropical Medicine and Military Surgery, and it is perhaps a sign of the times that the section on the legal side of medicine is disproportionately large. There are no fewer than 44 contributors, all recognized experts in their own particular fields.

The subjects are arranged alphabetically and this makes for uneven reading. The sudden transition from, say, "Anus, incontinence of" to "Aorta, coarctation of" or from "Labour, trial of" to "Larynx, diseases of" cannot be accomplished except with a crash of mental gears.

References are given at the end of each article and it is of interest to note that at least four articles by regular R.A.M.C. officers are mentioned in the text.

This annual will be very welcome to the busy practitioner with little time to spare for reading. He will here find recent work adequately covered in condensed but readable form, and the wide field covered will give him a broad survey of current thought and problems.

The book is a handsome volume. The green binding has been redesigned by a well-known artist, and a somewhat larger type-set has been used. There are 72 plates and 28 illustrations which are more than adequate. As an additional feature in Coronation year there is an article by Dr. Charles Singer, entitled "Medicine in the Reign of Elizabeth I."

R. J. G. M.

**AN INTRODUCTION TO GENERAL PRACTICE.** By D. Craddock, M.B., Ch.B., D.Obst., R.C.O.G. London : H. K. Lewis. 1953. Pp. xv + 553. 42s.

This is an excellent small book dealing with all aspects of General Practice. It gives an insight into practice and is recommended to R.M.Os. who wish to bring themselves up to date in all branches of Medicine that they are likely to see in their consulting rooms.

C. M. M.

**THE NATIONAL HEALTH SERVICE : A Guide for Practitioners.** Edited by Max Sorsby, L.M.S.S.A. Edinburgh : E. and S. Livingstone. 1953. Pp. xii + 267. 12s. 6d.

The general conception of this little book is excellent ; but its execution suffers from multiple authorship, treatment of the different subjects being rather uneven.

One would like to know how the National Health Service deals with the problem of the "difficult patient" whom no practitioner would willingly have on his list. The care of the Unmarried Mother and Child Guidance also merit more attention. The section on National Insurance would be much improved if the financial benefits were set out in tabular form. The services provided by the Local Health Authority have not been given the prominence which their importance demands. The lengthy chapters on the B.M.A. and the Coroner, though excellent in themselves, do not form part of the National Health Service and are unnecessary in a book of this type.

In view of the frequent changes in the National Health Service it is a pity that this little book is not published in looseleaf form so that the busy G.P. can keep his copy up to date by the purchase of cheap amendments from time to time. This would increase the usefulness of the book enormously.

T. C. R. A.

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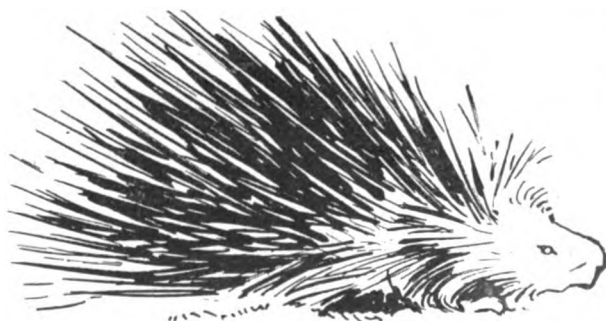
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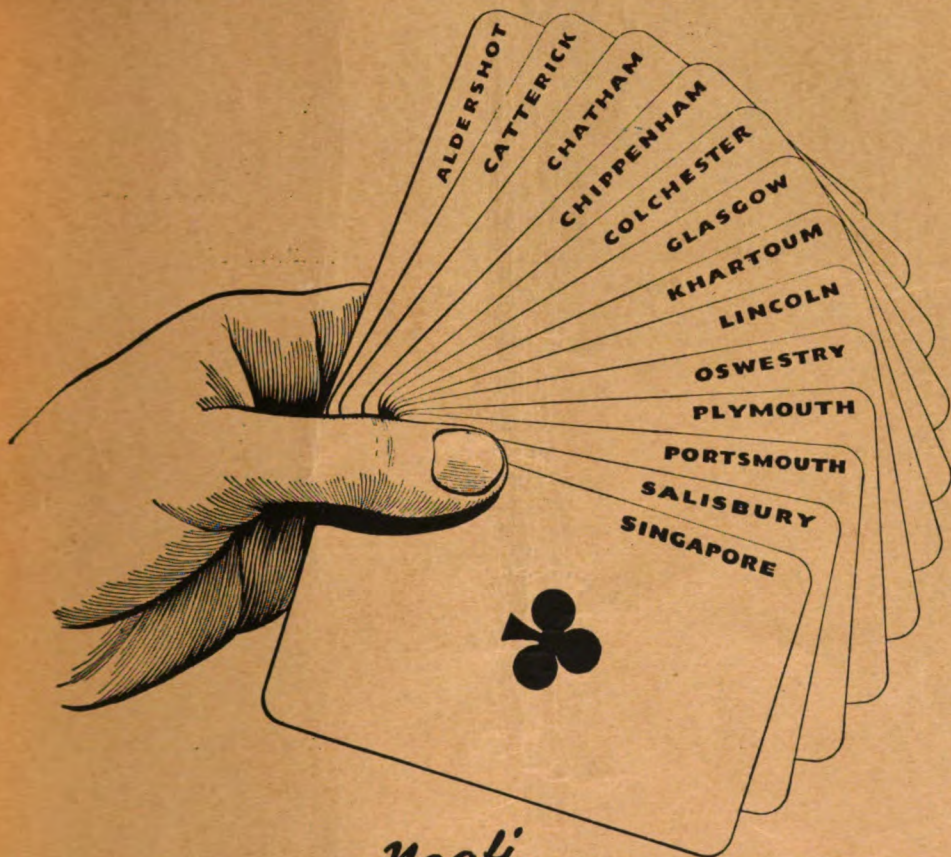
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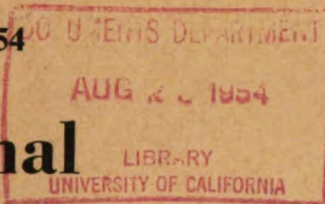
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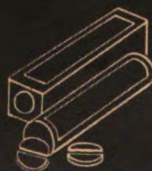
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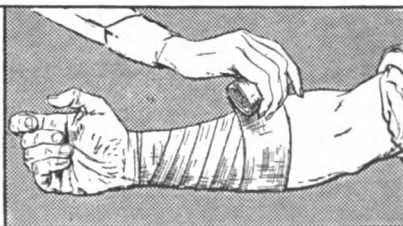
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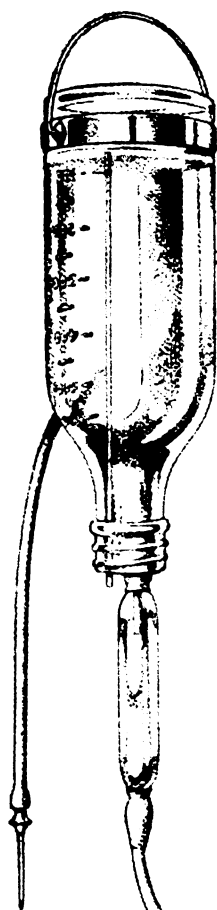
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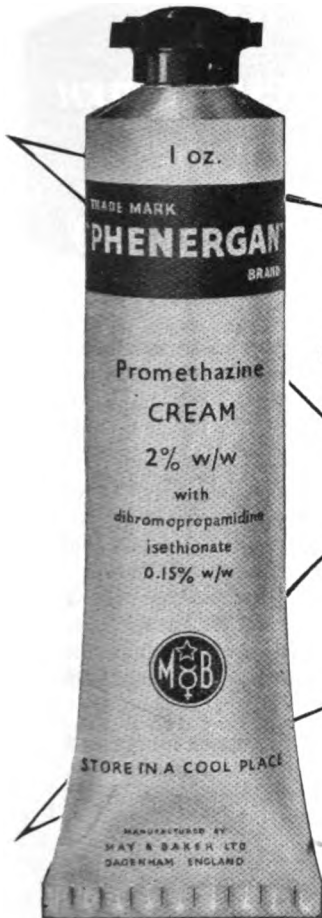
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# Journal of the Royal Army Medical Corps

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## *Original Communications*

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### AN EPIDEMIC OF INFECTIVE HEPATITIS APPARENTLY DUE TO A WATER-BORNE AGENT

BY

Major T. C. R. ARCHER, M.B., B.S., M.R.C.S., L.R.C.P., D.P.H.

*Royal Army Medical Corps*

#### INTRODUCTION

THE objects of writing this paper are :

- (1) To record some of the epidemiological features of an apparently water-borne epidemic of infective hepatitis.
- (2) To emphasize the potential danger to health of the dual system of water supply : purified water being used for drinking and cooking purposes, and untreated water from a polluted source for washing and conservancy. This epidemic shows what may happen when the two supplies are inadvertently mixed.
- (3) To survey briefly the minimum requirements to ensure a safe drinking water from a supply infected with the virus of infective hepatitis.

The epidemic to be described occurred in two military units occupying the same camp in the New Territories district of Hong Kong during the four-month period of March-June, 1950. Investigation showed no source of infection, but strong evidence is available that it was introduced by means of the water supply.

In unit A, which was approximately 500 strong, 73 cases occurred. These were all soldiers below the rank of sergeant. Eight cases occurred in unit B, a unit of approximately 150 men. These were divided as to rank : 2 officers and 6 other ranks.

Sporadic cases of infective hepatitis have always occurred in military units



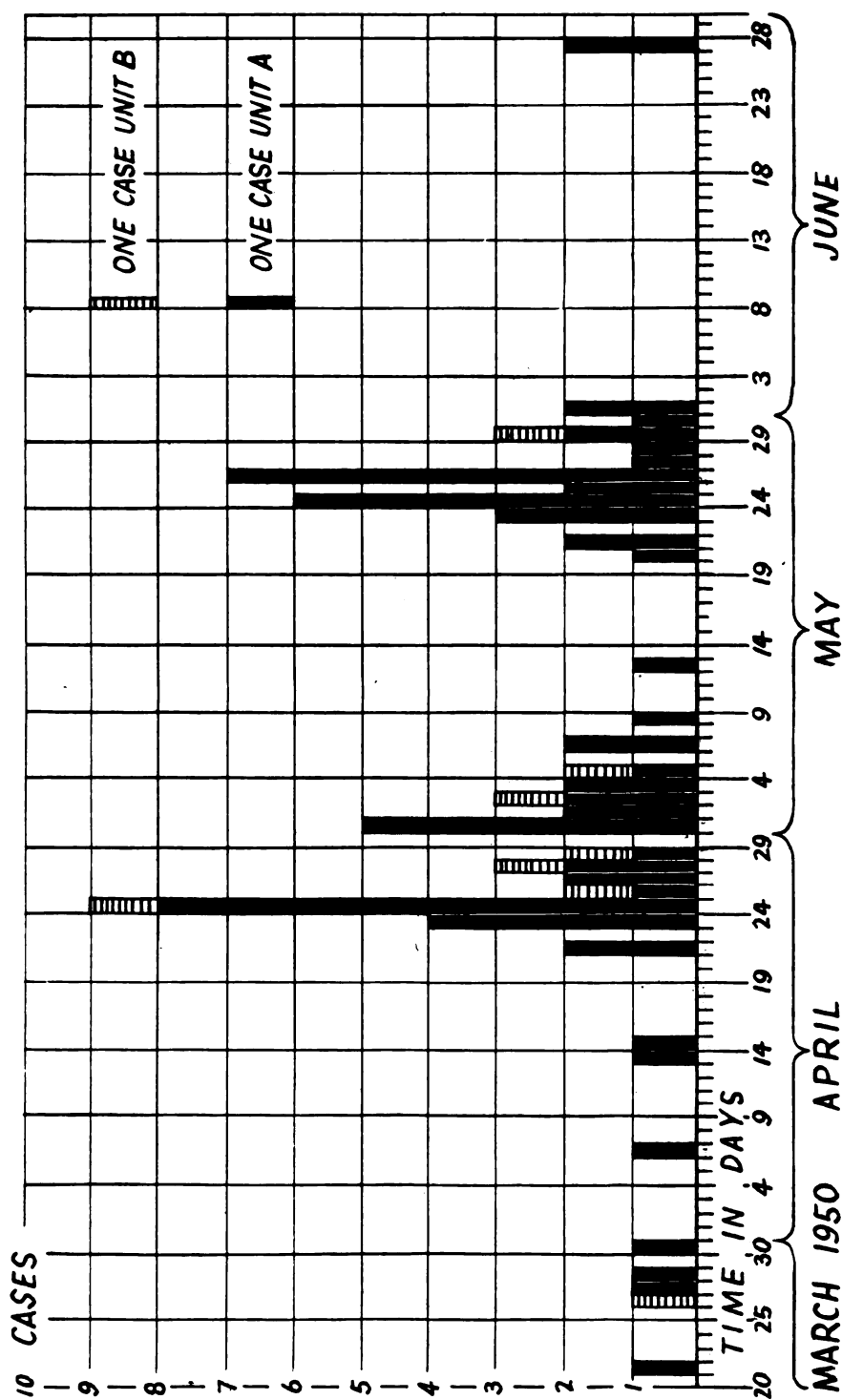


FIG. 1  
THE DAILY INCIDENCE OF CASES

stationed in the New Territories district, especially since the reinforcement of the Hong Kong garrison in June, 1949. Cases showed a tendency to increase with the onset of the wet season (towards the end of March). It is noteworthy that no cases were notified from either unit in 1950 prior to the epidemic. During the period of the epidemic 44 cases of infective hepatitis were notified from other camps in the New Territories. The incidence in these camps will be compared later with that of units A and B.

TABLE I

Case Nos.	Date	Unit A	Unit B	Total
<b>Wave 1</b>				
1 ... ..	22nd March	1 other rank	—	1
2 ... ..	27th "	—	1 officer	1
3 ... ..	28th "	1 other rank	—	1
4 ... ..	29th "	1 " "	—	1
5 ... ..	31st "	1 " "	—	1
6 ... ..	7th April	1 " "	—	1
7 ... ..	14th "	1 " "	—	1
8 ... ..	15th "	1 " "	—	1
		7 other ranks	1 officer	8
<b>Wave 2</b>				
9, 10 ... ..	22nd April	2 other ranks	—	2
11-14 ... ..	24th "	4 " "	—	4
15-23 ... ..	25th "	8 " "	1 other rank	9
24, 25 ... ..	26th "	1 other rank	1 " "	2
26, 27 ... ..	27th "	2 other ranks	—	2
28-30 ... ..	28th "	2 " "	1 other rank	3
31, 32 ... ..	29th "	1 other rank	1 officer	2
33-37 ... ..	1st May	5 other ranks	—	5
38, 39 ... ..	2nd "	2 " "	—	2
40-42 ... ..	3rd "	2 " "	1 other rank	3
43, 44 ... ..	4th "	2 " "	—	2
45, 46 ... ..	5th "	1 other rank	1 other rank	2
47, 48 ... ..	7th "	2 other ranks	—	2
49 ... ..	9th "	1 other rank	—	1
50 ... ..	13th "	1 " "	—	1
		36 other ranks	6	42
<b>Wave 3</b>				
51 ... ..	21st May	1 other rank	—	1
52, 53 ... ..	22nd "	2 other ranks	—	2
54-56 ... ..	24th "	3 " "	—	3
57-62 ... ..	25th "	6 " "	—	6
63, 64 ... ..	26th "	2 " "	—	2
65-71 ... ..	27th "	7 " "	—	7
72 ... ..	28th "	1 other rank	—	1
73 ... ..	29th "	1 " "	—	1
74-76 ... ..	30th "	2 other ranks	1 other rank	3
77 ... ..	31st "	1 other rank	—	1
78, 79 ... ..	1st June	2 other ranks	—	2
		28 other ranks	1	29
<b>Wave 4</b>				
80, 81 ... ..	28th June	2 other ranks	—	2
<b>GRAND TOTAL</b> ...		73 other ranks	8	81

## THE EPIDEMIC

*Prodromata*.—From February, 1950, onwards, medical officers working in the New Territories were reporting sporadic cases of a short-term fever with the following characteristics :

- (1) Duration of illness, 3–5 days.
- (2) Unilateral headache (frontal and/or retro-orbital).
- (3) Pain on moving the eyes.
- (4) Pyrexia up to 103° F. (the temperature chart was not characteristic).
- (5) Nil else abnormal.
- (6) Complete recovery.

This condition was variously diagnosed as being sandfly fever (although sandflies are not common in Hong Kong), acute sinusitis, and dengue. Expert opinion was that these were cases of dengue transmitted by *Aedes albopictus*. This mosquito is prevalent in Hong Kong in springtime, and is a proved local vector. This syndrome began to appear in units A and B in March, 1950 (together with a few cases of jaundice), at first sporadically but later in epidemic proportions ; 51 cases were reported for the week ending 22nd April. These cases showed anorexia in addition to the above clinical features. Within a week 34 of these cases had developed jaundice, the remaining 17 doing so later. Further cases followed rapidly until 81 had been notified. Unfortunately, complete records of the number of cases showing the prodromata but not the jaundice were not kept. For convenience of study and description the incidence of cases has been divided up into four waves as follows :

Wave 1.	22nd March–15th April	...	...	8 cases
Wave 2.	22nd April–13th May	...	...	42 „
Wave 3.	21st May–1st June	...	...	29 „
Wave 4.	28th June	...	...	2 „
Total				81 „

(See Fig. 1 and Table I)

*Wave 1 (8 Cases)*.—The first case (a corporal of unit A) was notified on 22nd March. Five days later came the second case, who was an officer of unit B. Three further cases (all from unit A) followed rapidly. A week elapsed before the next case, which was succeeded by two more at the end of a further week.

*Wave 2 (42 Cases)*.—The first two cases were notified on 22nd April, to be followed by more than one notification daily until 6th May, the greatest number (9 cases) being notified on 25th April. Cases dropped to nothing on 30th April, but rose again to 5 on the first day of May, falling away to nothing again by 7th May. Two further cases were notified on 9th and 13th May. Thirty-six of these cases were other ranks of unit A, the remainder being one officer and 5 other ranks of unit B. It is interesting to note that the officer (case No. 31) had previously suffered from infective hepatitis in Italy in 1945. Reference to Fig. 1 shows graphically the explosive nature of the epidemic during this period.

**Wave 3 (29 Cases).**—This commenced on 21st May, rapidly built up to a peak of 6 and 7 notifications daily on 26th and 28th May, and almost as rapidly died away to nothing by 2nd June. All cases were other ranks, 28 from unit A, and one from unit B.

**Wave 4 (2 Cases).**—Two other ranks of unit A, notified on 28th June.

Reference to Fig. 1 shows clearly the trend of the epidemic ; a few cases in wave 1 ; two explosive outbursts in waves 2 and 3 ; and finally two apparently stray cases twenty-seven days later (wave 4). The date of onset of jaundice has been taken as the day of commencement of the disease for the purposes of record.

**Clinical Features.**—All cases developed into the classical picture of infective hepatitis. All were mild in character. Average stay in hospital was six weeks. Two cases relapsed and were detained for more than three months. There were no deaths. Laboratory facilities were limited and did not permit of complex biochemical investigations.

Unit A (on 15th July) and unit B (on 15th August) removed to other camps in the New Territories, being replaced by an infantry battalion from Camp P. Up to November, 1950, no further cases had been reported from any of these units.

#### INVESTIGATION AS TO SOURCE AND MODE OF INFECTION

**Plan of Investigation.**—This was as follows :

1. Examination of the camp hygiene with special reference to
  - (a) Overcrowding in sleeping quarters ;
  - (b) Standards of hygiene maintained in kitchens and canteens ;
  - (c) Vermin and insect infestation ;
  - (d) Washing arrangements, conservancy, and refuse disposal ;
  - (e) Water supply.
2. Check of the syringe sterilization technique in the regimental aid post of unit A, which served both units.
3. Interview with each patient, inquiry being made as to :
  - (a) Length of stay in Hong Kong prior to onset of infective hepatitis ;
  - (b) Age ;
  - (c) Places of eating, sleeping, bathing and washing, both in and outside the camp ;
  - (d) The taps from which water was drawn for drinking and washing water during the previous three months, also the type of water used for washing the teeth ;
  - (e) Any abnormality observed in the quality of the drinking water during the previous three months, giving the date of such abnormality (if possible) ;
  - (f) Inoculation history, history of injections (including those for venereal disease and tattooing) during the previous six months.
4. Investigation of the incidence of infective hepatitis in the local civil population.



## FINDINGS

*General Topography.*—The camp was situated in a long valley about two miles wide, running east and west. Hills varying in height between 800 and 3,000 feet run in an almost complete chain both north and south of the valley. The valley soil is sandy clay overlying volcanic rock; as one ascends the hill slopes, the soil becomes thin and poor, being covered with low scrub and showing frequent outcrops of rock and deep scarring water-courses. The streams in these courses provide the main sources of water in the New Territories. They are an uncertain supply, frequently running dry towards the end of the dry season (October to April). The valley is intensively cultivated (with the exception of the camp areas), either as rice-fields or market gardens. Small Chinese villages are scattered throughout the valley, the nearest being within half a mile of the camp. The general standard of hygiene in these villages is low by occidental standards. The market gardens are heavily manured with human faeces, both from the local villages and the urban areas of Hong Kong. Pending use, it is stored in open pits scattered all over the valley. These pits are excellent sources of fly-breeding, and frequently caused outbreaks of bacillary dysentery in near-by military camps.

*The Camp Site.*—Is one of the oldest in the New Territories. It has been used by British troops on and off for the last forty years. The larger section (occupied by unit A) lies on the southern slope of the hill range bounding the northern side of the valley. The southern edge of this section is bounded by a small river, known as the River Indus, flowing from east to west. The smaller section (occupied by unit B) lies on low ground 200 yards upstream, on the opposite bank.

Up to March, 1950, a company of Gurkha infantry occupied a camp on the river bank a further four hundred yards upstream. This unit used the river for washing purposes. No cases of infective hepatitis were notified from this unit.

Higher up still, the river took in smaller streams from irrigation systems of rice-fields and market gardens and passed in the vicinity of a number of villages. It is reasonable to assume that the river was heavily polluted by the time it reached the camp occupied by units A and B: this was confirmed by presumptive coli counts, which were never less than 180 plus per 100 ml.

*Climate.*—The summer is wet, hot and humid, rain falling almost every day. The winter is cold and dry. Apart from scattered showers at Christmas, rain falls only between April and October, averaging 100 inches a year. Most of this is lost to the sea, as drainage is very rapid. Water is short towards the end of the winter. The temperature range is from 40° F. in the winter to 95° F. in the summer. Summer humidity is high, often reaching 80 per cent. relative humidity.

*Examination of the Camp* (general layout in Fig. 2).

The camp was constructed of Nissen and American Pacific type prefabricated huts. Although these huts were in a bad state of repair, they were probably

the best accommodation available in the New Territories at that time. Sleeping quarters, kitchens, dining-halls, washing facilities and latrines were all provided in separate huts.

1. *Sleeping Accommodation*.—In unit A, 40 men slept in each hut, giving a spacing of 400 cubic feet per man. In unit B, the huts were smaller and accommodated men at the rate of 600 cubic feet per man. The natural and forced ventilation (powerful overhead fans) were both good.

2. *Kitchens*.—These were constructed of prefabricated huts or corrugated iron-roofed shelters without side walls. Properly drained concrete floors were provided in all cases.

In unit A, the other ranks' kitchen was clean and well maintained. Preparation and storage of food was good. Hot water and soap, but no disinfectant (such as calcium hypochlorite solution) was employed in washing up. Refuse bins were not rat-proof. The dining-hall, which adjoined the kitchen, showed heavy rat-infestation.

The sergeants' mess kitchen was inadequate, both as to size and facilities and to cleanliness. It consisted of a room about 15 feet square and a small larder; this to cater for 30 sergeants.

The officers' mess kitchen was satisfactory with the exception of the food store, which showed heavy rat-infestation. It catered for 20 officers.

In unit B, the other ranks' kitchen was a wooden hut in a bad state of repair. It was impossible to keep this clean and the standard of hygiene was low. The officers and sergeants (10 in all) shared a Nissen hutted kitchen which was clean and well maintained.

3. *Canteen*.—Unit A ran a large N.A.A.F.I. canteen which was used by both units; this was generally clean and well run. Arrangements for the storage and preparation of food were both good. Hot water and washing soda, but no disinfectant, were used in washing up. In addition to the usual hot suppers, tea, cakes, and beer, this canteen sold locally grown raw fruit and aerated soft drinks made on the premises. The latter were made from fruit syrups (obtained from Great Britain), carbon dioxide, and the local drinking water. The canteen staff (all local Chinese) were clean and regularly checked by the regimental medical officer of unit A. No changes of staff, and no illnesses, had occurred during the previous six months.

4. *Fly- and Rat-infestation*.—Fly-infestation was not heavy either during the epidemic or in the previous three months. In November, 1949, both sections of the camp showed heavy rat-infestation (*Rattus rattus* predominating), especially in the officers' mess kitchen of unit A. This was cleared with difficulty by poison. Further inspections in April, 1950, showed that infestation had recurred in the other ranks' sleeping quarters and the officers' quarters of unit A. A further poison campaign brought this under control, the estimated kill being 400. Rat-proofing of the officers' mess kitchen was put in hand, but not completed until the epidemic was over.

5. *Washhouses*.—These were provided on the basis of one for each sub-unit of unit A, and one for the whole unit in unit B. Separate accommodation was available for officers and sergeants in both units. Each washhouse consisted of hand basins, showers, and slipper baths, with hot and cold running water. All taps were clearly marked to indicate that the water supplied was unfit for drinking purposes, the supply (except for the officers and sergeants of unit A) being untreated river water. Sullage water was trapped for grease, and then piped to the river.

6. *Conservancy*.—By water carriage to septic tanks whose effluents discharged into the river. Water for this system and the washing of all personnel, except the officers and sergeants of unit A, was derived from the river, the drawing-off point being two hundred yards downstream from the outfall of the septic tank serving the smaller section of the camp.

7. *Water Supply*.—This was obtained from two sources: that for drinking and cooking purposes was supplied by the Public Works Department of the Hong Kong Government (referred to as the P.W.D. water supply). This was upland surface water obtained by tapping streams high up on the surrounding hills. The risk of pollution at source was small, there being no villages or cultivated land, and very little grazing carried on, in the catchment area. This supply was purified (by the P.W.D.) by passage through coarse sand filters followed by chlorination, the latter being carried out by the addition of calcium hypochlorite from a drip-can. As might be expected, this did not give uniformly good results; it took no account of variation in the rate of flow of the water, which was considerable. Further chlorination was therefore carried out in the camp, water being pumped into storage tanks (marked in Fig. 2) on the hill slope above the camp. Here it was superchlorinated, detasted, and pumped to a higher tank, and from there fed by gravity to distribution points throughout the camp. These were:

- (a) All kitchens.
- (b) The N.A.A.F.I. canteen.
- (c) The washhouses and latrines for officers and sergeants of unit A.
- (d) The standpipes marked *W*, *X*, *Y*, *Z*, in Fig. 2.

This storage tank was 60 feet higher than the rest of the camp, and 10 feet higher than the storage tank for the river water supply. One of the big problems of living in the New Territories was the shortage of drinking water which occurred towards the end of the dry winter season. This had frequently occurred in the past in this camp, and had been solved by cutting off the P.W.D. supply to the majority of the washhouses and latrines during the winter months, replacing it by a supply from the river running through the camp. The intake was the point marked *ε* in Fig. 2, which we have already seen was 200 yards below the outfall of the septic tank of the smaller section of the camp. This water was pumped to storage tanks above the camp (marked in Fig. 2) and then distributed by gravity to washhouses and latrines, excepting those used by the officers and sergeants of unit A.



In order to simplify the change-over from one supply to the other, each washhouse and latrine was fitted with two series of delivery pipes, one from each supply ; the system of fitting is shown diagrammatically in Fig. 3 ; depending on whether P.W.D. or river water was to be used, so one stopcock would be open and the other closed.

It will be observed that if both stopcocks are open at the same time, and there is sufficient difference of pressure between the two supplies, it is quite possible for water to pass from one system to the other. This dual system was considered dangerous by the military medical authorities and on their advice it had been decided to increase the P.W.D. supply and eliminate the river

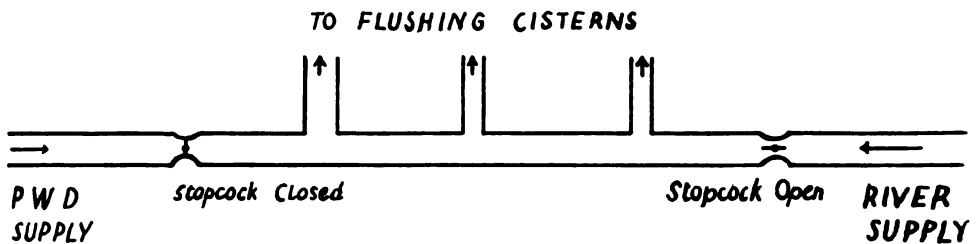


FIG. 3

DIAGRAM SHOWING SYSTEM OF DELIVERY PIPES IN LATRINES  
(The Latrine is depicted as using River Water)

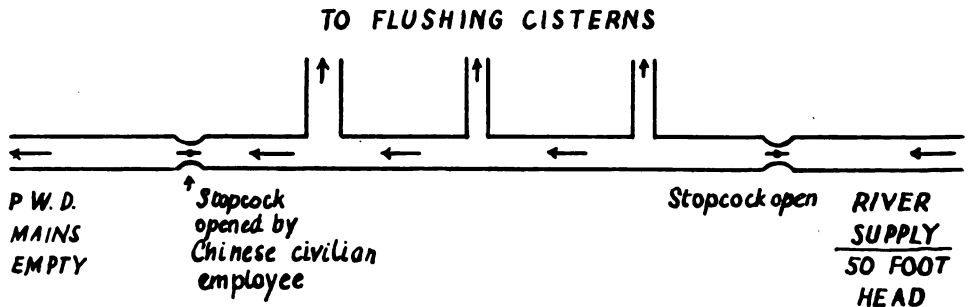


FIG. 4

DIAGRAM TO SHOW HOW RIVER WATER ENTERED THE DRINKING WATER SYSTEM VIA THE  
CANTEEN EMPLOYEES' LATRINE

supply entirely. This project was in hand when the epidemic broke out, but did not come into operation until 1st June, 1950. As an interim measure, chlorination of the river supply was advised but not carried out until 27th April, when the epidemic was well under way. During March and April, 1950, and possibly earlier, there were short periods when the P.W.D. supply failed entirely (up to two days at a time), water being brought in by tanker from other camps. In one of these times of shortage, a member of the Chinese civilian staff (N.A.A.F.I. canteen) evidently found that by opening both stopcocks in the N.A.A.F.I. staff latrine (marked in Fig. 2), river water would pass into the drinking water system in sufficient quantity to provide adequate supplies to the taps in the canteen. The quartermaster of unit A actually caught one member of

the staff on two occasions opening both stopcocks. The first occasion could not be ascertained, but the second is known to have been 17th April. Evidence from cases would indicate that river water passed up into the drinking water system as far as the standpipes W, X, Y and Z, and taps in the other ranks' kitchen of unit A and all kitchens of unit B. The piping of both systems was checked for leaks during the investigation, but no leaks were found.

### *Syringe Sterilization Technique*

The technique employed in the regimental aid post of unit A was checked and found to be that normally employed in the Army, syringe and needles being wrapped in lint and boiled for twenty minutes. The majority of both units had been re-inoculated with T.A.B. vaccine in February, 1950. No complaint of this vaccine was made by other units using it. Also, one would have expected cases to have been spread over a longer period of time if the infection had been syringe-borne.

### *Incidence of Infective Hepatitis in the Local Population*

This was difficult to assess as the disease is not notifiable in Hong Kong, inquiry of civilian doctors indicating that there were always a few cases occurring, but nothing in the nature of an epidemic since 1945. The writer made extensive inquiries in the local villages, but failed to establish the occurrence of any cases in 1950.

### *Results of Interviews with Patients*

The following points are worthy of note :

(a) No case occurred amongst the officers and sergeants of unit A. This suggests transmission of the disease as being by some agency which was not common to all groups in the camp. The only obvious one is the water supply.

(b) Cases were fairly evenly divided among the sleeping huts of unit A, with the exception of huts 47 and 48. In unit B, cases were not so spread out, but were not confined to one hut.

(c) The majority of cases had served at least ten months in Hong Kong before contracting the disease, the longest period being twelve, and the shortest (case No. 31) two months, so it is unlikely that the disease was imported into Hong Kong from abroad. The majority of cases had spent all their time in this camp since arrival in Hong Kong, with the exception of manœuvres and occasional day visits to the urban areas of the colony.

(d) The majority of cases occurred in men aged 19-21 years. This is not considered significant, being the average age of the population at risk.

(e) The period of time between prodromata and the onset of jaundice was just under six days. This confirms the findings of other epidemics.

(f) Analysis of the number of cases drawing drinking water from the various standpipes and taps does not reveal anything significant except that all taps were used in equal numbers. The breakdown was as follows :

- Unit A.* Standpipe *X* used by 19 cases (all other ranks).  
 Standpipe *Y* used by 21 cases (all other ranks).  
 Standpipe *Z* used by 18 cases (all other ranks).  
 All three standpipes 7 cases (all other ranks).  
 Standpipes *X* and *Y* 1 case (other rank).  
 Standpipes *X* and *Z* 1 case (other rank).

All the above cases had also consumed water from the taps in the dining-hall. Five cases stated that they never drank water, but regularly consumed the locally made soft drinks in the N.A.A.F.I. canteen.

- Unit B.* Water drawn from tap in officers' mess kitchen : 2 officers.  
 Standpipe *W*, and tap in dining-hall : 6 other ranks.

There is no evidence that troops deliberately drank washing water.

(*g*) In unit A, washhouses were allotted on the basis of one to each squadron ; cases were fairly evenly distributed amongst all of them.

(*h*) Fifty-six cases from unit A and 6 from unit B habitually used river water for cleaning their teeth. If this had been the mode of infection, one would have expected cases to have arisen sporadically over a longer period.

(*i*) Fourteen cases had bathed in the river, a point against the disease being Weil's disease, or transmitted by this means.

(*j*) Fifty-four cases had regularly consumed soft drinks from the canteen.

(*k*) Six cases regularly consumed meals in public restaurants outside the camp ; 16 were in the habit of buying raw fruit from local Chinese vendors on the outskirts of the camp.

(*l*) Forty cases had been inoculated less than three months prior to contracting the disease, 38 being inoculated in the regimental aid post of unit A. A further 16 had been inoculated between three and six months previously. Five cases had injections for other reasons (including venereal disease) within three months of the onset of the disease.

(*m*) Two cases had been tattooed within three months, the operations being done by different artists in Hong Kong and Great Britain. This would exclude tattooing as being the mode of infection.

(*n*) Thirty-three cases had observed abnormalities in the taste and appearance of the drinking water, the usual comment being that the water was brown and turbid with an unpleasant taste for a few days. Twenty-four cases were able to give some indication as to the dates on which this had occurred, as follows :

5th March	...	...	...	...	...	1 case
15th to 24th March	...	...	...	...	...	3 cases
31st March and 1st April	...	...	...	...	...	3 cases
Mid-April	...	...	...	...	...	17 cases

(One case had noted 17th/18th April in his diary.)

## DISCUSSION

*Diagnosis*

This is considered to be infective hepatitis. Clinically, cases were typical mild infective hepatitis. The heavy rat-infestation of the camp suggested a mild variety of leptospirosis. This was excluded on the following counts :

- (a) No albuminuria.
- (b) White blood counts were either normal or showed a leucopenia.
- (c) Agglutination tests were negative.

Serum hepatitis was also considered, but thought unlikely because :

- (a) Only 40 of the cases had been inoculated within three months, which is the recognized incubation period for this disease. In addition, the officers and sergeants of unit A had also been inoculated recently but had suffered no cases.
- (b) Syringe sterilization technique was adequate.
- (c) Recently, Hobson and his co-workers (1952) have drawn attention to the significant incidence of tattooing in cases admitted with infective hepatitis to a military hospital in Hong Kong. But in the present series only two had been tattooed within three months, and another seven within six months of onset of the disease.

*Origin*

No connection could be established between cases in this epidemic and earlier cases arising outside the camp in either the military or civil communities. The source of infection must therefore remain a mystery. It is interesting to note that a number of observers have noted an apparent carrier state for infective hepatitis in Asiatic peoples [Cameron (1943), Kligler *et al.*, quoted by Havens (1948) and Mackie (1950)], infections in childhood producing an immunity to re-infection and at the same time a carrier state. This may have been responsible here.

*Mode of Introduction and Spread*

Our knowledge of the mode of transmission and spread of infective hepatitis is still far from complete. The two great difficulties in the way of research are, firstly, that we are dealing with a virus, and, secondly, the lack of a suitable susceptible animal other than man for carrying out transmission experiments. Published work indicates, however, that the disease has been spread by :

- (a) Droplet infection.
- (b) Ingestion of food or drink contaminated by the urine or faeces of infected persons.

The points for and against these methods of transmission being responsible in the present epidemic, together with the possibility of transmission by rodent or insect vector, will now be considered.

**DROPLET INFECTION.**—The sporadic incidence of cases in wave 1, and the appearance of two cases in wave 4, are suggestive of a droplet infection, as also is the fact that the cases from unit A were living under overcrowded conditions. The evidence against this being the mode of spread in the present epidemic is very much stronger:

- (a) Reference to Fig. 1; the incidence of cases does not indicate a spread from one case to another, assuming an incubation period of 27-35 days (as observed by Pickles (1939) and others).
- (b) The overcrowding of sleeping quarters was more apparent than real, the ventilation, both natural and artificial, being good.
- (c) The explosive nature of the epidemic in waves 2 and 3.
- (d) The officers and sergeants of unit A were not affected, though they were in close daily contact with the affected groups. With droplet spread one would have expected at least one case from them.

**Infection by Insect or Animal Vector.**—This method has not yet been incriminated, but must be considered in view of the fact that the disease has been transmitted by infected food and drink. The three most likely vectors in this case are rats, flies and mosquitoes.

Rat-infestation was highest in the kitchen of the officers' mess of unit A, yet no cases arose from this group. Fly-infestation was slight, and showed little or no variation between one part of the camp and another. The New Territories of Hong Kong is an area of high endemicity for malaria. The Army relies entirely on personal preventive measures, no permanent land control measures being carried out. These measures include the use of mosquito-proof clothing and insect-repellents after dark, and daily Paludrine prophylaxis. The incidence of malaria in the military community is negligible.

The above points would suggest that any of these methods of spread are unlikely in this case.

**INGESTION OF FOOD OR DRINK CONTAMINATED BY THE URINE OR FÆCES OF INFECTED PERSONS.**—For convenience this will be considered under the following heads:

1. *Consumption of Food infected prior to Arrival in Camp.*—The two main sources of food were Army rations and N.A.A.F.I. canteen supplies, both of which were almost entirely imported from outside. If this had been the source of infection, one would have expected cases in epidemic proportions from other camps in the New Territories, because all units drew supplies from the same depots.

2. *Infection during the Preparation of Food or the Washing-up Process.*—This could have occurred in either the kitchens or the canteens. The canteen was clean and generally well run, as was the kitchen (other ranks, unit A) which fed most of the cases: whilst the badly run kitchen of the sergeants of unit A had no cases. One would have expected also that early in the epidemic cases would

have occurred amongst the cooks, but this was not so. The only professional foodhandler to contract the disease was the ration storekeeper of unit B (case No. 28), who was notified at a relatively late stage. Infection during food preparation would not explain the two officer cases of unit B. If defective washing up had been the means of spread, one would have anticipated cases from the sergeants or officers of unit A, whose crockery was used communally. (Other ranks of both units used their own individual crockery and cutlery, washing them up individually.)

3. *Defective Conservancy System.*—The whole system was checked and no defect was found.

4. *Water Supply.*—A small number of water-borne epidemics, either proved or suspected, has been reported from various parts of the world, mainly by American observers. The high incidence of infective hepatitis in United States troops in North Africa and Italy during World War II is thought by a number of observers (especially Long, 1950) to have been due to consumption of infected water, though really conclusive proof is lacking except in one small epidemic which occurred in a mountain unit in Italy. In an epidemic in a children's holiday camp in the United States, Neefe and Stokes were able to prove the water supply as being the means of transmission by reproducing the disease in human volunteers fed on samples of infected water.

The evidence in this epidemic is not so conclusive, but is strongly in favour of the infection having been introduced by the water supply. The epidemic opens with a few cases, then follows with two explosive outbursts which die away almost as quickly as they arise, and finally closes with two cases long after the remainder. This picture is very characteristic of a water-borne or food-borne epidemic. Our previous paragraphs have shown food as being most unlikely; now as to water.

We know that the Chinese canteen employee opened both stopcocks of the Chinese staff latrine on 17th April. The water pressure in the river-water-supplied system was quite sufficient to force water into the drinking water system of pipes, which would be empty or nearly so due to the failure of the P.W.D. supply. Thus, the drinking water standpipes and taps in the dining-halls were delivering untreated polluted river water. The only part of the system in which this could not happen was that supplying the officers and sergeants of unit A, because the gravity feed storage tank for P.W.D. water was 10 feet higher than that for river water (see Fig. 2). Analysis of the answers given by patients indicates that 17 of them observed abnormalities in the drinking water in the middle of April, one being able to quote the exact date as 17th-18th April. Taking the incubation period of infective hepatitis as being 27-35 days (Pickles, 1939), an explosive outburst of cases was to be expected on or about 21st May; actually this is what happened. We also know that the same Chinese employee opened the same two stopcocks on at least one earlier occasion when the P.W.D. supply failed. Unfortunately, we do not know the date. Reference to the patients' evidence indicates that river water entered the

drinking water system in the periods 15th–21st March and 31st March–1st April. Examination of Fig. 1 shows that in wave 2 there were two peaks of incidence—the first on 25th April and the second on 1st May. Taking the same incubation period as before, the occurrence of cases on these dates is reasonable if infected water was introduced into the drinking water system in the periods 15th–21st March and 31st March–1st April. The next big point in favour of the epidemic being water-borne is that the one group who could not unwittingly have consumed river water at any time had no cases (the officers and sergeants of unit A, their water supply system being such that river water could not back up into it as apparently it did in the rest of the camp). Finally, note how the epidemic terminated so dramatically when the river water supply was cut off entirely on 1st June. It is thought that the two cases which made up wave 4 arose from droplet infection from wave 3, though no direct connection between the two groups of cases could be established.

TABLE II

Camp	Strength (approx.)	Infective Hepatitis		Diarrhoea		Environment compared with Camps A and B
		Cases	%	Cases	%	
A and B ...	650	81	12.4	23	3.9	—
C ... ..	200	2	1.0	2	1.0	Worse
D ... ..	100	2	2.0	4	4.0	"
E ... ..	750	1	0.1	16	1.6	"
F ... ..	750	2	0.2	22	2.2	Better
G ... ..	250	2	0.8	3	1.2	"
H ... ..	250	2	0.8	9	3.6	Worse
J ... ..	250	1	0.4	—	—	Better
K ... ..	300	1	0.3	3	0.9	Worse
L ... ..	500	2	0.4	10	2.0	"
M ... ..	750	6	0.8	13	1.4	"
N ... ..	600	4	0.6	8	1.2	"
O ... ..	600	6	1.0	3	0.5	Better
P ... ..	750	3	0.4	5	0.6	"
Q ... ..	750	4	0.5	45	5.6	Worse
R ... ..	500	3	0.6	20	4.0	"
S ... ..	180	1	0.5	—	—	Better
T ... ..	80	1	1.2	—	—	Worse
W ... ..	100	1	1.0	—	—	"
TOTALS ... (C to W only)	7,660	44	0.6	163	2.1	—

## NOTES

1. All columns headed "‰" are attack rates expressed as a percentage.
2. Diarrhoea is taken as an indicator rather than bacillary dysentery, because all diarrhoeas were treated in regimental aid posts in the first instance, only those resistant to sulphonamide therapy or showing other unusual signs being admitted to hospital. The majority of diarrhoeas were bacillary dysentery, other causes being rare. But note that the high figure for camp Q was an epidemic of amœbic dysentery.
3. Standard of environment. Factors taken into account in making assessment were: purity of water supply, type of conservancy system, living accommodation, standard of food hygiene, personal hygiene, and general cleanliness of the camp area.

### Case 2

This may well have been the source of infection for cases arising in waves 2 and 3. He developed jaundice on 27th March, and was probably infectious for at least a week before that. His infective excreta during this period would be passing into the septic tank of the smaller section of the camp, and then into the river 200 yards above the intake for the river water supply. It has been shown that the virus of infective hepatitis is hardy (Neefe *et al.*, 1947), being capable of surviving at 4° C. for several years. It is not unreasonable to postulate that, once infected, this septic tank remained a reservoir of infection for the river water.

It is interesting to note that the actual consumption of water appears to be necessary to produce the disease ; use of infected water for oral toilet does not seem to be of importance.

### The Attack Rate

Taking the population at risk as being 650, 81 cases gives an attack rate of 12.4 per 100. This would indicate that there were a large number of sub-clinical cases, or that the majority of those at risk had already developed an immunity.

### Other Infections from the Untreated Washing Water

It is remarkable that other epidemic water-borne diseases did not show themselves in similar dramatic fashion. The fact that 98 per cent. of those at risk were protected by T.A.B. vaccine, and the absence of a near-by source of cholera, probably explains the absence of these two diseases. Diarrhœa figures, however, for the period March-June, 1950, show a high attack rate compared with the average for camps in the New Territories at that time. Table II gives the incidence of cases of infective hepatitis and diarrhœa in all camps in the New Territories, together with a brief comparison of the relative standards of environment and hygiene. The table shows that the attack rate for both conditions was much higher than the average for the remaining camps. The fact that the latter were more primitive, and in some cases did not maintain such high standards of hygiene, would indicate some gross defect in the camp occupied by units A and B.

### Purification of Water infected by the Virus of Infective Hepatitis

Investigation of this epidemic prompted the writer to consult the literature as to experimental work done on this subject, as it appeared to be one of both military and civilian interest. Neefe, Baty, Reinhold and Stokes (1947) carried out experiments in which the effects of commonly employed purification procedures were tested. Samples of infected water treated in various ways were fed to human volunteers, and the incidence of infective hepatitis compared with a control group fed on untreated samples. Results showed that clarification



(coagulation, settling, and filtration), followed by exposure to a total residual chlorine concentration of 1.1 parts per million for thirty minutes, was the minimum treatment necessary to ensure inactivation of the virus. These results suggest that standards for purification of water supplies in the field should be :

- (1) Clarification, which must include filtration.
- (2) Superchlorination (exposure to 2 parts per million total residual chlorine for a minimum period of thirty minutes).
- (3) Detasting as at present.

#### SUMMARY

1. An epidemic of infective hepatitis which occurred in two military units (sharing the same camp) of the Hong Kong garrison is described.

2. Eighty-one cases occurred, representing an attack rate of 12.4 per 100. The epidemic appeared in four waves, and showed the explosive character of a water-borne infection.

3. Clinically all cases were mild, with no deaths and two relapses. The average stay in hospital was six weeks. The differential diagnosis is discussed.

4. The investigation of the epidemic is described in some detail. It was carried out under the following heads :

- (a) Examination of the camp environment.
- (b) Interview with all patients with special inquiry as to living habits, inoculations, injections and tattooing.
- (c) Incidence in the local population.

5. Findings are discussed in the light of present known or suspected modes of transmission of infective hepatitis.

6. The evidence available indicates the water supply as being the means of transmission. The camp was supplied by water from two sources : firstly, a well-purified source for drinking and cooking purposes ; and secondly, a polluted river water for washing and conservancy. On at least two occasions the first source failed, and a Chinese civilian employee connected up the river supply to the drinking water piping system. The relation of this action to the occurrence of cases is discussed. Confirmation that this was the means of infection is made by the freedom from infection of a large group in the camp who had separate water supply, and the dramatic end to the epidemic when the polluted river supply was cut off.

7. The incidence of infective hepatitis in this camp and other camps in the same district is compared.

8. The danger of the dual water supply system is stressed.

9. A short note is given on recent experimental work on the purification of

water infected with the infective hepatitis virus. This indicates that thorough clarification (including filtration), followed by superchlorination for a period of at least thirty minutes, is necessary.

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## EXERCISE "MEDICAL CAMBYSES"

D.G.A.M.S. ANNUAL EXERCISE, 1953

BY

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IN our schooldays most of us could declaim in chronological order (provided we were not interrupted) the names and dates of the kings of England ; but perhaps it is as well that we were not asked to do the same for the kings of Persia, as it is so difficult to remember to count backwards for those who reigned B.C.

Cambyses came between Cyrus and Darius the Great, and he ruled from 529 to 522 B.C. in the happy, happy days when a wing commander was a man having charge of thirty-two elephants. He conquered Egypt in 525 B.C., and is said to have treated the Egyptians with great brutality, and to have slain Apis, their sacred bull, with his own hands. From Egypt he planned expeditions to Carthage, Ethiopia, and the Siwa Oasis. The first two were abandoned, and the Siwa army vanished in the Western Desert, and no trace of it has ever been identified with certainty to this day. Although certain aspects of his history might tend to endear him to us nowadays, his personality seems to have been on the whole less endearing than psychopathic. We chose him for the title of our exercise because it seemed to us that to mislay an entire army implied a weakness in logistics.

The exercise was a study of hospital planning for a force of half a million men, and the Director-General decided to place the setting of it in the Middle East, where during the war so many lessons were learned which he felt we were in danger of forgetting.

The old taunt of "sand in your shoes," which was long kept up in Normandy by many who failed to realize that they themselves were developing into fine specimens of what I call the "Bocage Bore," may still be heard occasionally ; and it is probably a useful corrective to any veterans of the Eighth Army who may forget the proverbial tendency of the British Army to be prepared for the last war. Sir Winston Churchill, in his classic book on the war in the Sudan, *The River War*—two pages of quotations from which are included in the exercise report—tells us that much the same cry was raised more than fifty years ago, when it was said that "Frontier warfare was not to be learned on the playing fields of Egypt" (1).

If our minds are inflexible, and if we allow our tactical conceptions to become over-specialized, there is obviously a danger that much experience of one form of warfare may be a positive barrier to success in another. Napoleon considered that deserts were the most difficult of all obstacles to the passage of an army ; and Von Ravenstein, an Afrika Korps general, called the desert "The Tactician's Paradise and the Quartermaster's Nightmare." Our field ambulances may disport themselves in the paradise, but the units behind the divisions, and the wounded wearily jolting over endless desert tracks, are caught

in the toils and frustrations of the nightmare. The supreme importance of deserts to us, however, is that they have been great training grounds, as Moses realized when he trained his army in Sinai for the conquest of Canaan. A forty-year training programme was rather severe, but after years of slavery in Egypt the Children of Israel must have been a pretty undisciplined rabble of D.Ps.

Sir Brian Horrocks has called the desert "The Crucible of War," and in that crucible varied past experience, tempered by the requirements of modern warfare, was fused to produce the medical tactical doctrines which we accept today. But after all this pompous justification of the value of desert experience it may be admitted that the streams of nostalgic reminiscence to which Eighth Army veterans are notoriously addicted gush from some deeper source. There was something about the desert, or perhaps it was mainly about its temporary population, which compelled a sort of thrawn affection. As they watched the piles of sand which had showered from their clothes and baggage being swept from their rooms in Shepheard's or the Continental Hotel they knew what Laurence Sterne ought to have meant when he wrote "Was I in a desert I would find out wherewith in it to call forth my affection" (2).

After the Opening Address and Introduction to the Exercise, Lieut.-Colonel D. Macfie of the Cameron Highlanders gave a most interesting and up-to-date lecture on "The Situation in the Middle East."

The theme of the exercise was the medical planning for an Army Group with the task of resisting a two-pronged Fantasian attack designed to reach the Suez Canal and our Egypt base in the west, and the oil-fields of Persia and Saudi Arabia in the east.

We were lucky to be able to use a similar exercise which the Director-General ran at Fayid in 1948 when he was D.M.S., M.E.L.F. At that exercise he had given a lecture on how the D.M.S. would approach his problem and appreciate the situation, and he now gave a similar lecture to launch us in our appreciation of the "Cambyses" situation. His lecture was followed by a series of talks and playlets dealing with the various factors of importance in medical planning in the Middle East and elsewhere.

First, of course, came Army Health—a lecture by the Director of Army Health, followed by a short playlet in which the D.M.S. discussed with A.M.D.5 in the War Office the health problems likely to give him most trouble.

Next the Director of Quartering, Major-General W. H. D. Ritchie, described the organization of a base—a lucid insight into the administrative complexities of modern warfare for which we were most grateful. Yet another quotation from *The River War* could have provided the text for this lecture—"Victory is the beautiful bright coloured flower. Transport is the stem without which it could never have blossomed. Yet even the military student, in his zeal to master the fascinating combinations of the actual conflict, often forgets the far more intricate complications of supply" (1).

Colonel J. T. Robinson followed General Ritchie with a comprehensive review of the medical problems in a base, and ended on a characteristic note with an admonition to us to be especially watchful for a fall in morale amongst those

employed in the base, who often include a high proportion of unstable officers. All are disappointed at not being more actively employed in combatant duties, and are subject to a variety of other causes of nervous strain. How well many who were lucky enough to be with active divisions will remember the kind of senior officer in the rearward areas who, disappointed at being unable to make direct assaults on the enemy, got it out of his system by persecuting those who could.

General Hospitals and C.C.Ss. were the subject of a playlet in which two retired officers in bed in a Millbank ward discussed the points on which their experience had taught them to concentrate in training. Many of the points were suggested in letters from retired officers with desert experience to whom we wrote for advice. A particularly prolific source of useful advice, maps and photographs was Lieut.-Colonel J. W. Wayte, whom many will remember as the enthusiastic war-time C.O. of 15 C.C.S. and 3 General Hospital.

This playlet, in the competent hands of the commandant of the Field Training School and his second-in-command, combined first-class entertainment with sound instructional value.

As a medium of instruction the playlet, sometimes called a "divided lecture," is now very popular, especially with those who support the definition of a lecture as "the transference of material from the lecturer's notebook to those of the audience without its passing through the minds of either." But care must be taken that the fun does not obscure the facts. Lieut.-Colonel Marks found exactly the right formula.

On the second morning a playlet about Desert Warfare gave us quite a Middle Eastern feeling with the actors shivering in tropical uniform, and C.S.M. Cross's stage setting with scenery painted by Pte. Protheroe, an expert who also made us a splendid exercise map, complete with a galleon just past the Pillars of Hercules and heading for the coast of Barbary, and cherubs puffing winds from the Himalayas, christened "Tensing and his brother" by Colonel Crosse. And since the Middle East in two wars would not have been the same without the Australians we were lucky enough to have some local colour in the playlet from Major W. W. McLellan, R.A.A.M.C., who has been attached to various units in the United Kingdom during the past six months.

Some of the points in this and other playlets were illustrated by a beautifully laid out demonstration of photographs and models, which was organized with immense enthusiasm and imaginativeness by Captain W. L. O'Brecht, R.C.A.M.C., a member of the Field Training School staff by virtue of an exchange with Canada, whose hard work we acknowledge with special gratitude.

The A.D.S. in the desert was the subject of a short talk, in which also the important points in desert camouflage were described.

No "guest artist" ever scored a more instantaneous hit than Brigadier G. A. Bond, the D.D.S.T. of Southern Command, who gave us an extremely entertaining and very important playlet combined with a lecture on movement by day in the face of enemy air superiority.

Ambulance cars may have to run by day in circumstances in which daylight

movement is prohibited or restricted, and, unless they are to rely entirely on the nebulous protection of the Geneva Cross, something on the lines of the "Bond System" may prove to be essential. Brigadier Bond's system is more than mere theory, as he elaborated it in great detail and practised it extensively in Germany when he was D.S.T. of Northern Army Group. Considerable speed is required if movement as a whole is not to be held up, and except on good roads this might not be suitable for vehicles conveying serious cases. Careful control is essential to the success of this method, and anyone who is interested in field training should read the précis of this serial in the exercise report.

We now turned from administrative to professional aspects and dealt with two most important subjects : the Prevention of Psychiatric Casualties, and the Effects of Heat.

It may be said that in the Army today the importance of hygiene and the great contribution which it can make to victory in war are fully recognized not only by commanders but by anyone intelligent enough to obtain a commission. This does not, of course, imply that we can expect to see this general recognition translated into unfailing attention to even the simpler rules of Health Discipline ; but luckily the modern soldier may be protected from the worst results of ignorance or negligence by the beneficent umbrellas of D.D.T. and antibiotics. Even that scourge of armies in the field—bacillary dysentery—against which we have no protection except impeccable hygiene, has most of the sting taken out of its tail by a pocketful of sulphasuccidine tablets.

This is all very satisfactory so far as the soldier's physical health is concerned, but nowadays his mental or spiritual health is even more important. In 1902 Colonel G. F. R. Henderson wrote : "The battlefield in the old days was a comparatively safe locality except at close quarters, but today death has a wider range, and although the losses of modern battle are relatively less the strain on the nerves is far more severe" (3). Not only the modern battlefield, but life itself in the "fifties" is even more of a strain than in 1902.

*Conduct of War* (1950) states : "Man is still the first weapon of war, and the morale of the soldier is the most important single factor in the war." Sound physical health has a direct effect on morale, and the existence of a good medical service greatly helps to sustain it ; but if we could only—as I believe we can and should—do something more direct and positive about the maintenance of mental health, then we might make a contribution to the efficiency of the Army, and eventually of the nation, of which we could be as proud as we are of all that has been achieved in military medicine, surgery, and hygiene. This was the subject of a playlet in which a divisional commander discussed the maintenance of morale and the prevention of psychiatric casualties with his A.D.M.S., A.Q., and a psychiatrist.

The danger of Effects of Heat in a theatre which includes the Persian Gulf is obvious, and this is a field in which we could not take advantage of all the recent advances in prevention, since an army cannot fight in air-conditioned buildings. But we learned that tanks can be air-conditioned, and of course many, many other preventive measures have made war in hot countries a very different affair from the days when the poor British soldier toiled around the

W. H. Wolstenholme, and the A.E.R. spokesman was Lieut.-Colonel G. S. Adams.

The discussions are always regarded as an essential element on our exercises, and at "Cambyes" they were very helpful. To those of us who could remember a similar engagement during Exercise "Medical Horatius," 1950, involving Colonel Drummond and Brigadier Harsant, it was very rejuvenating to see Major-Generals Drummond and Harsant on their feet together exchanging vigorous badinage; and when "the thunder of the captains and the shouting" had died down it was good to know that both of them approved of the Thomas splint, though Major-General Drummond feared that the modern generation of junior M.Os. did not fully appreciate its value, especially on active service.

As usual, a copy of the full report of the exercise will be sent to all who attended, and to major units. It is hoped that this report will be more easy to read than its predecessors, because we have substituted précis for the full verbatim reports of the playlets which gave former reports their somewhat forbidding bulk, in which much of the greatest interest and value is embedded in masses of unappetizing matter like the currants in a N.A.A.F.I. cake.

Distinguished visitors to England who attended the exercise were Brigadier-General W. J. Kennard, U.S.A.F., M.C., Chief of the Medical Branch at S.H.A.P.E.; Colonel W. D. Refshauge, R.A.A.M.C., D.D.M.S. at Army Headquarters in Melbourne; Lieut.-Colonel J. Barr, R.C.A.M.C., representing the D.M.S. of the Canadian Army; Lieut.-Colonel P. Costain, R.C.A.M.C., from Northern Army Group; and, of course, our old friends and frequent visitors, Colonel Walter Moursund and Lieut.-Colonel Sailindra Nath Chatterjee. We were also glad to have with us Surgeon Captain C. B. Nicholson, R.N., and Group Captain J. S. Wilson, R.A.F. Medical Services.

When the D.G. in his closing address thanked various people for the hard work involved in staging the exercise, those of us who were principally involved smiled smugly and wondered if he realized just how much of the hard work he had himself done for us on this occasion; not only by handling "Fantasian Interlude" himself, but by providing us with the essential nucleus of the exercise by adapting to 1953 his 1948 framework and his very exhaustive appreciation. We are, of course, hoping that for his 1954 exercise he will write the comic relief playlet himself without more ado, and would respectfully prophesy that should he take up this sort of thing in his eventual retirement there will be no need to worry about "boo-proof" galleries at his first nights.

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## EFFECTS OF HEAT

BY

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### INTRODUCTION

A HUNDRED years ago in the days of that great soldier, Lord Roberts, a medical officer beginning a tour of duty in India could not expect to return home for at least ten years. Indeed, he would have been fortunate to come home at all, for every summer a large number of deaths occurred there from effects of heat, malaria, dysentery, enteric, cholera and plague. It is interesting to note that even in those days it had been observed that new arrivals to the tropics were considerably more susceptible to disease and more especially to summer heat.

The loss of life from heat effects was appalling in Mesopotamia during the First World War, and its lessons had to be learnt once again in Paiforce in the early years of the Second World War. Between May and September, 1942, in the Gulf, 2,364 casualties from the effects of heat occurred among our troops, half of them in August and 65 per cent. on board ship or during or shortly after disembarkation.

### TYPES

Nowadays two main conditions are recognized : firstly, heatstroke or heat hyperpyrexia ; and secondly, heat exhaustion, sometimes known as heat prostration. It is known that both are due primarily to living in a hot climate and not to solar radiation which causes sunburn, a subject with which this article is not concerned.

### ÆTIOLOGY

Among the environmental conditions which favour the development of both these syndromes are a high atmospheric temperature (something over 100° F.) and a high relative humidity. Fortunately, in hot countries these two conditions do not often occur together. As a general rule the weather is either very hot and dry as in deserts, or slightly cooler and more humid as is found in jungles or near the sea. An exception to this rule is found in the Persian Gulf, where heat and humidity tend to occur together, and this may account for the evil reputation of the area.

Another important climatic factor is stagnation of air or lack of air movement, which prevents the body from cooling by the evaporation of sweat. In a desert climate the skin feels dry though active sweating is taking place. Other environmental factors are lack of proper clothing and lack of suitable housing—this latter being found too often in the improvised conditions of active service.

Internal conditions in the body itself which predispose to heat conditions are malaria or any other febrile condition, excessive use of alcohol, depletion



of fluids and chlorides (either deficient intake or excessive loss as in profuse sweating), and especially fatigue and exhaustion. These heat effects are more likely to occur in newcomers to the tropics, although they may be seen in indigenous persons. For example, in the Mecca Pilgrimage in September, 1951, there were 600 deaths in a single day from the heat, but none of the Sudanese pilgrims, used to a similar climate, suffered from its effects. Here is an example where heat effects could have been prevented :

An Indian draft numbering 1,134 disembarked at Basra one morning in August. Conditions that day were as follows : Shade temperature, 116° F. (max.), 87° F. (min.). Relative humidity, 23.5 per cent. The ship had docked the previous evening, and the troops had spent the night between decks in the torrid heat of the docks. They disembarked at 0400 hours, marched to the station, entrained in goods wagons, and arrived at the transit area at 0900 hours. Upon arrival, they were marched, carrying their kit, for nearly a mile to their camp, where they had to draw and pitch their own tents. This was the last straw ; weak with hunger, exhausted and overwhelmed by the heat, the men went down like ninepins, and a hundred cases were admitted to hospital. It was shown at the inquiry that, owing to heat and monsoon storms, the feeding arrangements had broken down on board ship, and many of these men had had little or no food for two days ; a fact which had an important bearing on the occurrence.

#### ADAPTATION

There are two types of adaptation to a warm climate, that to a desert climate which persists and that to a jungle environment which does not persist ; however, the person already adjusted to a jungle climate easily adapts himself to a desert climate, but not vice versa. Acclimatization most probably is a question of endocrine and vasomotor adaptation, which increases the blood circulation in the skin vessels and so enables the body to lose heat. There is increased sweating and less salt is lost in the sweat. Even when the body is adapted to the heat, mental and physical efficiency are appreciably reduced in the tropics compared with the temperate zones. As yet there are no means of knowing in advance that a person is likely to be intolerant of tropical conditions.

#### CLINICAL PICTURE

##### *Heatstroke*

The first syndrome, heatstroke, is a breakdown in the heat regulating mechanism of the body, with serious damage to the central nervous system and a tendency to congestive heart failure. The clinical picture may be divided into two stages :

The premonitory stage, when the presenting symptoms are exhaustion, headache, vertigo, restlessness and mental irritability. There may be polyuria with frequency of micturation. Polyuria rarely occurs in a healthy person under tropical conditions, and it is well to remember that this may be a warning of impending heatstroke. The symptoms closely resemble an acute anxiety state.

On examination, the patient's temperature is 99° F. to 100° F., he has a rapid bounding pulse, an increased respiration rate and exaggerated deep reflexes.

In fully developed heatstroke the patient passes into a deep coma ; the face is congested, the skin hot, dry and burning ; the rectal temperature is over 106° F., the pulse is rapid and thready, and the breathing becomes fast and stertorous. The central nervous system shows focal or generalized signs, including small pupils, absent tendon reflexes, extensor plantar responses and even incontinence of urine and fæces. The condition is fatal if the high body temperature persists for many hours, but if treated early, the patient usually responds and recovers. In the rare fulminating type of case there may be no premonitory stage, but on admission to hospital the patient may be unconscious or may rapidly pass into coma.

In heatstroke the plasma chlorides are reduced, but the urinary chlorides are usually normal or only slightly diminished.

*Diagnosis.*—To give the patient the best chance of survival, the diagnosis must be made in the premonitory stage. A number of cases have developed in hospital patients after surgical operations, in those suffering from fever, dysentery, or during treatment for peptic ulcer. Any case of fever is a candidate for heatstroke. Malaria, especially the cerebral M.T. form, may cause, simulate or complicate heatstroke, and if this is suspected, in spite of negative blood smears, intravenous quinine must be given immediately. In the differential diagnosis, coma due to some form of cerebral hæmorrhage, diabetes or uræmia must be considered. At the same time high fevers due to infective conditions like enteric, typhus, relapsing and meningococcal fevers must also be excluded.

### *Heat Exhaustion*

*Type 1.*—The second condition, namely heat exhaustion, is seen more frequently as a result of heat exposure. Of the predisposing causes already mentioned, fatigue and exhaustion, lack of food, fluids and chlorides, unsuitable clothing, constipation and old age are important factors.

Heat exhaustion usually develops slowly and the majority of cases occur during the hottest part of the summer at peaks of high atmospheric temperature, e.g., 115° F. for three to four days on end. There may be nothing more than a feeling of weakness or lassitude ; or the patient may experience headache, giddiness, anorexia and mental confusion in the early stages. When fully developed the condition is characterized by syncope, sweating, vomiting and muscular cramp. On examination, the patient is pale with a cold, clammy skin, rapid pulse and low systolic blood pressure. The diastolic pressure is usually about 80 mm., this low pulse pressure being indicative of the commencement of peripheral vascular failure with a 30—50 per cent. reduction in the total plasma volume due to vaso-constriction. In this stage even slight changes of posture, e.g., sitting the patient up to examine him, may precipitate an attack of syncope and fatal collapse. The urine is diminished in quantity with a lowered content of chlorides and urea, whilst in the blood the chlorides are diminished and urea content high. The picture is like that of acute shock.

*Type 2.*—A second type of heat exhaustion, first recognized during the last war, is called thermogenic anhydrosis. It occurs in the second half of the summer and is characterized by diminished sweating due to fatigue of the sweat glands. Thirst and polyuria occur but there is absence of syncope, vomiting and cramps. On examination, the patient appears restless and excited, his temperature is 99° F. to 100° F., with a pulse of 100—130 p.m. and an increased respiration rate. The skin shows changes such as prickly heat and there may be some generalized lymph-glandular enlargement. Biochemically, there is some salt deficiency, but it is not as great as in ordinary heat exhaustion. The clinical picture is like that of effort syndrome with the addition of skin rash. The prognosis is fairly good, although there may be a tendency to heart failure and it may be complicated by salt or water deficiency.

Although the patient usually recovers from heat exhaustion, he may die, and heat exhaustion may be followed by heatstroke.

#### TREATMENT

##### *Prophylaxis*

The treatment of all effects of heat can be dealt with together. Of course, most important of all are the preventive measures, largely the application of common sense to men lacking climatic adjustment. The sea voyage enables certain precautions to be taken in advance; for example, tests for urinary chlorides can be performed and, if these are found reduced, extra salt is prescribed; all sick, especially those suffering from any fever or the effects of seasickness or skin diseases, should go straight to hospital and not be delayed in transit. During the last war many of the German troops were placed in the hot houses for three to four weeks before leaving by air for North Africa to join Rommel's Afrika Korps.

Before disembarkation men must get enough rest, plenty of fluids and salt, and a good meal served as late as possible. All water-bottles must be filled before disembarkation. Contrary to general opinion, thirst is not a reliable guide to water requirements. The soldier in the tropics must be taught to drink enough water. The consumption of alcohol must be strictly controlled.

These preliminary measures will not be possible when troops are flown out to tropical areas, though careful selection of fit personnel beforehand is important.

It is best for the troops to disembark in the cool of the early morning. Their dress, probably shirt sleeve order, will have to be laid down in advance. Physical work, *e.g.*, unloading kit and equipment, is best done in the morning and evening, not in the heat of the day or when men are tired. The work should be less strenuous and at a slower rate than that to which the men are accustomed at home. It is necessary to keep up their morale and keep them interested by recreation, graduated exercise and mail and newspapers from home. There must be plentiful supply of rest centres—cool rooms with heatstroke centres attached. Appetising food without too much protein or fat must be provided, and the men must rest after the midday meal. Plenty of drinking water must be available from stand-pipes on the dock side. Salt replacement is important,

the extra daily requirements varying from  $\frac{1}{4}$  to  $\frac{3}{4}$  oz. (7 to 21 g.) depending on the height of the thermometer, the degree of acclimatization and the amount of active work performed. The salt tablets on issue are best taken in a glass of water or preferably soda water and never in the form of compressed tablets, which may, if dehydrated, be passed unchanged. The salt supplement is more important in the first month until the men are acclimatized and less salt is lost in the sweat. The available rest rooms must be cooled by fans, punkas, khushkus tatties, or air conditioning, and in addition there must be plenty of showers and baths for washing. On the line of march, M.T. and ambulances must accompany the column; adequate meals must be given and water-bottles filled from stand-pipes or water-carts at all halts. The medical officer must be especially vigilant to detect early heat exposure cases and send them to the nearest heatstroke centre.

### *Curative Treatment*

The curative treatment of heatstroke must be undertaken in a cool room provided with fans and plenty of water and ice—*i.e.*, the heatstroke centre. In the premonitory stages, the removal of clothing, giving sufficient fluids and salt and relieving of constipation are all that is usually necessary. In fully developed heatstroke, the patient must be stripped of his clothing, placed on a string bed, slab, or stretcher and covered with a wet sheet and his temperature reduced by evaporation of cool water from the surface until the rectal temperature has reached 103° F. to 102° F., when he is placed in bed between blankets and the rectal temperature recorded every ten to fifteen minutes. Even when consciousness has returned he is not out of danger. The return of the deep reflexes to normal is a valuable guide to prognosis. If the temperature rises again the treatment must be repeated. Thereafter he must be kept in a cool room, fluids and salt being replaced as necessary. If malaria is suspected he should be given the benefit of intravenous quinine and intramuscular mepacrine without delay. Venesection and saline infusions may be needed, though care should be taken not to overload the circulation.

Heat exhaustion is best treated by bed rest and a liquid diet with replacement of fluids and salt, keeping the patient in a cool ward. It may be necessary to give intravenous infusions of isotonic saline or, for badly shocked patients, reconstituted plasma. A fluid intake and output chart should be kept and the urinary chlorides should be checked frequently. With these measures the patient usually recovers fairly quickly.

### EXAMPLES

Here are some examples of lack of judgment and gross carelessness in the heat. In March, 1916, Colonel Sir Victor Horsley, a total abstainer, then in his sixtieth year, proceeded to Mesopotamia as Surgical Consultant. It is said that he lived in the Officers' Mess and was shocked by the amount of alcohol consumed by his colleagues, who he felt were candidates for heatstroke. He worked unceasingly in warm clothing without a topee. On the afternoon of

15th July, 1916, when the atmospheric temperature had reached 120° F. in the shade, he was admitted to hospital with a temperature of 104° F., which fell slightly under treatment ; an examination of the blood for malaria gave negative results. In the course of the following day his temperature rose to 108° F. ; he became unconscious and died of heatstroke at 8.30 p.m.

During the last war a detachment of Indian troops (total 386) disembarked at Basra from a transport to a paddle-steamer, on which they were packed very tightly. The journey to the jetty on this steamer should have taken about fifteen minutes, but since there was a convoy crossing the ferry, the detachment was kept close-packed on the paddle-steamer, in mid-stream, for four hours. They had been suffering from seasickness and the effects of heat and were in poor general condition, and had not had a meal before leaving the transport. When finally put ashore they had to march about a mile to camp. The result was 59 cases of heatstroke.

In 1948 a keen combatant officer who had gained considerable experience in the Middle East was in charge of a series of physical endurance exercises for officer cadets in the Aldershot District, being part of their training to make them physically fit. On a hot afternoon in July, after a strenuous morning's work and a rushed midday meal, two cadets collapsed on the line of march and died a few hours later of heatstroke. It would seem that those concerned did not realize that the effects of heat can occur in this country given a hot summer and the adverse conditions to provoke heatstroke in apparently healthy individuals.

#### CONCLUSIONS

From these insistent remarks it will be realized that it is not what ought to be done or what can be done but what must be done to prevent effects of heat. Not only is it essential to combat fatigue in the individual soldier by every available means, but also to pay particular attention to general man management in a hot climate. It is the duty of the commander of a port, on the advice of his A.D.M.S., to make a sound plan and provide in advance the answers to all the medical problems for the "A" and "Q" branches before difficult situations arise.

Finally, the application of sound common sense to men working in the heat will prevent loss of manpower and deaths which otherwise would certainly occur.

## THE KNAPSACK AND PACK

AN HISTORICAL AND PHYSIOLOGICAL SURVEY WITH PARTICULAR  
REFERENCE TO THE BRITISH SOLDIER

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*(Continued from page 88, April issue)*

### PART III

#### CLINICAL ATTITUDES TO PACK PALSY, PACK FRACTURE, PACK EXHAUSTION

We may divert here to review some of the more important clinical aspects of load carriage by the soldier. It has for long been known that chilling of a sweating back, when the pack is taken off after a strenuous march, may predispose not only to what is generally called lumbago or rheumatism, but also to inflammation of the kidney and lung infection. In the Effort Syndrome—the “Soldier’s Heart” of the earlier authors—the load acts as but one of the “stress factors” in an individual who tends to break down even with the psychological stresses of civil life.

In 1949, Rogers (59) pointed out that compression effects may occur on the subclavian blood-vessels and brachial plexus of nerves, during their course from the neck, under the clavicle, and into the arm (Costoclavicular Syndrome or Acroparæsthesia of Walshe). Such pressure may be due to congenital anomalies in their pathway, or from drooping of the shoulders as a consequence of fatigue of the shoulder muscles. In susceptible individuals, the mere carrying of a handbag, postbag or respirator may induce the disorder, with resulting pain, cyanosis, weakness, numbness or tingling in the neck, arm or hand. Stammers, in 1950, described the syndrome in new recruits, and reintroduced the old expression “Pack Palsy” (60), as used by Pringle and Parkes. In the past, this condition has been ascribed to pressure on vessels and nerves, and by tight bands and straps in the armpit. However, the axillary vessels and nerves run through the inner side of the arm, and as long as the arm is free to swing, it is not likely that such structures will be directly compressed.

The presence of bands passing high in the armpit is nevertheless indicative of a short pack situated high on the back. Since such a pack is likely to be bulky, disturbance of the centre of gravity may occur, with undue pull on the shoulder muscles, and drooping of the shoulders as a probable consequence. It would hence appear that “Pack Palsy” is essentially a manifestation of the

Costoclavicular Syndrome, and due only indirectly to the presence of the straps. Stammers showed the condition to arise from unaccustomed loads on the shoulders of young, untrained recruits of the weedy, asthenic type. The symptoms disappeared, in most cases, after a few weeks of outdoor life, good food, and graduated exercises for the shoulder muscles (60).

In recent years yet another disorder has been elucidated which is of interest in the problem of the load on the back. Such disorder is due to congenital weakness, present in some individuals, of the intervertebral cartilages. When these are exposed to undue compression, the softer central disc (nucleus pulposus) is dislocated, with resulting pressure on the spinal cord or its emergent nerve roots. Floyd and Silver have shown by electromyographic studies that, with full flexion of the spine, the Erector Spinæ muscles are relaxed and support of the spine thrown on its ligaments (61). Since, in gravity mechanisms, the spine and its cartilages act as a fulcrum, heavy loads on the back (especially if the centre of gravity is displaced backwards) will considerably increase the pressure on the cartilages, and in such a circumstance dislocation of a cartilaginous disc is liable to occur. This may arise not only during marching with a load, but during the lifting of the pack, or during extreme flexion of the trunk, as with tying a shoelace. Weak intervertebral cartilages occur particularly in the cervical and lumbar regions, with symptoms referable to the neck or arm, and simulating the Costoclavicular Syndrome, or to the leg, producing a variety of sciatica.

Load carriage may lead not only to compression of blood-vessels and nerves, but on occasion even bone fracture may occur. Such "March Fracture," "Stress" or "Pack Fracture" has in the past masqueraded under a variety of names, and often been misdiagnosed. Because of the excess callus formation, it has even been confused with osteogenic sarcoma. During the Second World War the condition was shown to arise in susceptible individuals from the prolonged and repeated stresses of unaccustomed loads, especially in untrained recruits. The pull of muscles on the elastic bones appears to be the main cause, but more direct stress on bones when muscles are fatigued may be of some moment. The bones of the foot (see below) are most commonly involved, but the condition has been described in the neck of the femur, the upper end of the tibia and fibula, the hip bones, and even the ribs (62). During evolution, the adoption by man of the upright posture has introduced a number of mechanical disadvantages from which he has not yet recovered. The Costoclavicular Syndrome, Slipped Disc Syndrome, and "Pack Fracture" are probably some of the results of such disadvantages.

Prolonged and forced marches, with heavy and uncomfortable loads, may as we have shown be followed by such severe "Pack Exhaustion," both physical and mental, that men may fall out, or collapse in their tracks and even die. The mechanism and pathology of the condition is not clear, and hypoglycæmia does not appear to be an important factor (32). But exhaustion of such a grade undoubtedly acts as a severe "stress factor," with failure of the "Adaptation Syndrome," depletion of the reserves of the suprarenal glands, and a con-





1882



1888



1903



1908

FIG. 5  
SIDE VIEWS OF VARIOUS FORMS OF EQUIPMENT  
Showing evolution of straps in armpit





1937



1942 Battle Jerkin



1944



1951  
Experimental (Battle Order)



1951  
Experimental (Marching Order)  
(Supporting strap through armpit rises in  
Marching Order)

FIG. 6

SIDE VIEWS OF VARIOUS FORMS OF EQUIPMENT  
Showing evolution of straps in armpit. Short arrows indicate armpit straps.

sequent vasomotor shock which may be fatal. Of the conditions which may predispose to such an outcome, we have lack of food and sleep, climatic extremes, and poor morale. It was well known to Pringle in 1762 that marching with a load in a hot climate was conducive to death from heat stroke, but as a lesson this is still sometimes forgotten.

Although the disorders we have described are not common, they must be considered amongst the problems of the marching soldier. In the past, measurement of energy expenditure has been used in the classic experiments that have determined the maximum load and the best methods of carrying it. Such a technique has, however, at the best thrown light on the efficiency of muscle activity under short term and controlled laboratory conditions, and may not be a valid measure of the soldier's efficiency in carrying his load under the prolonged and variable stresses of the field. Furthermore, the technique may give no indication of the liability to the clinical disorders we have outlined above.

#### A.O.R.G. AND 1951 EXPERIMENTAL EQUIPMENT

As the outcome of the demands of the War Office Qualitative Requirement of 1950 for an improvement in personal load carriage equipment, research which had already commenced in A.O.R.G. was completed in the same year, and an excellent report produced by Lippold and Naylor (63). Working on the principle that the minimal disturbance of the centre of gravity of the body was desirable, an electromyographic technique was used to indicate activity in the back muscles when loads were carried in different ways. The results showed that more muscles are active with an unbalanced than with a balanced load, and that a long, narrow, flat pack produces less activity of the Trapezius and Sacrospinalis muscles than the high pack of the 1937 equipment. It was noted in the paper that "disproportional expenditure of energy does not necessarily mean disproportionate rate of fatigue." This would fit into the concept outlined above, that load carriage is more than a matter of muscle tone and contraction. As an outcome of the report, a new design of equipment was produced for Battle Order. In principle, this is a long, narrow, flat pack, balanced by ammunition pouches in front, and with the weight of the pack distributed between the shoulders and hips. Due to inverse relations of movements at the hip and shoulder joint during walking (64), a certain amount of bounce of the load is inevitable. Such a mode of load carriage, utilizing a long narrow pack, was already in use in Germany, Austria, Belgium and Denmark towards the end of the last century, and shoulder-hip carriage was the principle employed in the 1871 valise equipment. It will be remembered that Lavissee in 1902 strongly recommended a long, narrow, flat pack with shoulder-hip carriage. The present 1951 experimental web equipment (Z2 pattern) is based on the A.O.R.G. design.

#### KNAPSACKS AND FEET

During the Second World War some interesting experiments were carried out in America by Turrell and Robinson (65) on the relationship of heavy boots

to the energy requirements of the soldier. It was shown that the addition of one pound to the weight of shoes was equivalent in energy cost to the carriage of four pounds on the back. Recent unpublished work in this laboratory confirms the finding, but suggests that the ratio is nearer 1 : 2.5. The problem, however, is not a new one. Munson in 1901 (30) quoted a rash authority who stated that "one gramme on the shoe is equivalent to one kilogramme in the knapsack." Parkes in England, Morache in France, Roth and Lex in Germany, and Munson in America were all concerned with the importance to the soldier of rational footgear, and the effect of marching with loads on the arch of the foot, swelling of the foot and frictional blisters.

As early as 1855, Breithaupt described in young soldiers a condition of chronic painful swollen feet (*Fussgeschwulst*), due to prolonged or forced marches when carrying full knapsacks. Stechow, surgeon to the Prussian Guard, first showed in 1897, with the aid of the recently introduced X-ray technique, that the condition was due to a "hair line" fracture of the metatarsal bones of the foot (66). The French Army Surgeons Chapotot and Boisson described the condition in 1899 as "*Pied Forcé . . . provoqué par la marche des fantassins.*" During the First World War many cases of "March" or "Pack Fracture" of the foot were recorded, and before the Second World War a group of cases was published by Küntscher (67) and attributed to the rapid and intensive training of young German recruits. During the last war the disorder had so increased in frequency that in 1946 six papers dealing with the subject were reviewed in the same journal (62). New boots should be tried on by men wearing full marching gear, but it is doubtful if this is often done.

#### CONCLUSIONS

Lothian, in his historical review (41), has shown the conflict in the minds of generals between the "Essentials" of a soldier's load and the "Necessaries" of his mobility. In the history of all armies there are numerous examples of overburdened soldiers discarding excess or uncomfortable equipment in order to survive and do battle; and other examples where they have collapsed by the roadside, shackled to the knapsack, too exhausted to fight, or to consolidate what they had gained. We have noted the attempt to free the British soldier during the Boer War, and the effect of overloading him during the First World War. Colonel Marshall (68), of the American Army, has recently reviewed in a trenchant manner the problems of the soldier's load, and quoted numerous examples from the Second World War of the dire consequences of overload. Since the time of Professor Parkes and the Committee of 1865-1868, the physiologist, and sometimes the soldier, has preached to the unheeding a lesson still not yet learned. A soldier converted into a beast of burden inevitably loses his intrinsic, but most prized, weapons—his morale, his initiative and his audacity. Only the commanders can put this lesson into practice.

We have shown that in the history of load carriage there have been many trials and tribulations, and it is sometimes to be wondered whether the soldier is in fact better off today than he was with the valise equipment in 1871. It is

seen that there has been a great deal of repetition of earlier work due, often, to lack of knowledge of what had been done before. Although there have been great technical advances during the present century, the principles used today in load carriage were already well known long before the end of the nineteenth century. The acceptance of an equipment by one committee, and its rejection a few years later by another, recurs throughout the history we have traced. This is perhaps partly due to conclusions which were never valid ; but also to the fact that a load carriage equipment, like all military equipment, should always have a drill for its correct usage. This may in fact be practised by the inventors, or by the soldiers, in the early days of its use ; but in time such drill tends to become seriously neglected, or forgotten, particularly if it lacks simplicity.

The mode of equipment testing, by either laboratory experiments or field trials, is of great importance in the choice of the best tools for the fighting soldier. From the earliest days it has been an accepted fact that the opinion of an officer may not always be a good indication of the value of an equipment to the fighting soldier. Questionnaires have been used since the trials of 1865-1868 as a measure of the subjective effect on the user, but unless the questions are designed to eliminate bias, misleading information may be obtained. Furthermore, it may be impossible to draw sound conclusions, even from objective tests, however carefully carried out, unless the experiments are suitably designed and the data examined for statistical significance. Differences which are statistically significant may nevertheless be too small for practical consideration. The failure to appreciate the import of these various deliberations is found throughout almost the whole history of load carriage. As a result, much data has accumulated, but it is often difficult to draw valid conclusions.

It is with some dismay that one discovers that little is new ; that physiological methods have been used for nearly a hundred years. However, the various techniques (pulse rate, stress and pack tests, body temperature, sweat loss and energy metabolism, electro-myography and so forth) indicate, at the best, the short term effects on some particular bodily functions ; and they are not necessarily a valid measure of the efficiency of the whole man—the soldier—in carrying out his varying and prolonged military duties. This is particularly true of experiments limited to the controlled environment of the laboratory. For this reason, performance tests, simulating military tasks, and carried out under the realities of the field, should be included among the various methods of investigation in order to give a more complete evaluation of the problem. The scientific team is incomplete without the close collaboration of Service officers, experienced in field trials and exercises.

In the clothing worn, the equipment they use, and the loads to be carried, soldiers are essentially uniform and standardized. But it is to be remembered that in height, weight, muscular efficiency and military fitness, soldiers are predominantly individuals. The effect of a load, or a particular load carrying equipment, hence varies appreciably from man to man ; and in the same man,

with climate and terrain, training and experience, with the state of morale. It must be accepted that the vertical frame of the human body is not adapted for the carriage of heavy loads, especially by men marching in step and in military formation. The physiologist must consider the requirements, plan the experiments, consider all the relevant data, and then advise; but the final decision will always have to come from the commanders in the field, who alone are intimately conversant with the soldier's function, and the purpose of his equipment. Hence the load carried by the soldier, and the personal load carriage equipment, will probably always be a compromise between what is physiologically sound and what is operationally essential.

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# ENVIRONMENTAL CONDITIONS AND THERMAL COMFORT OBSERVATIONS IN W.D. ACCOMMODATION, MALTA

BY

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## PREAMBLE

HITHERTO the Maltese summer has been considered (by those who have not experienced it) a mild affair not calling for the provision of fans or other means of enhancing thermal comfort.

From the middle of October to the middle of June, climatic conditions in Malta certainly call for no measures other than space heating during the winter months, with windows soundly shuttered against the fierce winds and driving rain. During July, August and September, conditions can and do become objectionably uncomfortable, and, as can be seen from the figures at Table I, the climate is not unlike that of a humid tropic. Clearly the subjective impression of personnel posted to Malta is not sufficient evidence to invoke the provision of special measures, and the data at Table I relating to external environment cannot be directly applied to what is experienced within buildings be they living accommodation, workshops or offices.

The tremendous weight given to even the most flippant medical pronouncement is no doubt conditioned by Queen's Regulations, para. 80, which reads: "Medical officers are charged with advising general and other Os.C., *who will incur grave responsibility if such advice is neglected without adequate reasons*" (my italics).

This incitement to the development of a "Jehovah-complex," which—as Professor Crew has pointed out—is the *sine qua non* of every clinician, has merely caused embarrassment to the self-effacing social pathologist, and it has become the author's habit to back opinion with objective data whenever feasible.

Following several strong representations, the author thus undertook to assess as objectively as possible the internal climatic environment of W.D. accommodation during the summer months. This decision was unfortunately taken late in the season, and as the instruments required had to be borrowed from the Naval Medical Officer of Health, it was not possible to include more than three main studies, two relating to office conditions, and the third, which is the subject of the present paper, relating to conditions in O.Rs.' Married Quarters' kitchens.



## PRESENT STUDY

During tours of inspection the author had observed that the coal-fired kitchen ranges provided in O.R. M.Q. kitchens were seldom used, particularly in the summer months. On questioning, the two main reasons given were excessive fuel consumption and tremendous radiant heat output. Almost without exception the husband had purchased oil stoves so that his wife could work in reasonable comfort, the coal ration being accumulated and used in the open living-room fireplace and in the farmhouse boiler on wash days.

Clearly, the provision of coal-fired ranges as a sole means of cooking during the summer months is quite untenable if it can be proved that in using them working conditions become intolerable or detrimental to health; as the War Department is under the obligation to provide suitable apparatus in living accommodation for this purpose, an alternative must be found, and the appropriate fuel provided.

The matter was discussed with the staff officer concerned, who sponsored a trial of working conditions in representative kitchens in each of the main W.D. "estates" during the month of September.

TABLE I

Date	Max. Temp.	Min. Temp.	Highest Humidity	Highest Dew Point	Lowest Dew Point	Total Rainfall
JULY, 1951						
1st ...	86	71	72	63.9	54.4	Trace
2nd ...	86	72	82	66.7	54.5	
3rd ...	86	70	80	66.8	56.4	
4th ...	87	71	81	68.3	55.0	
5th ...	88	71	84	69.7	55.6	
6th ...	94	74	83	71.2	53.5	
7th ...	98	72	79	70.8	46.2	
8th ...	91	76	81	72.4	60.2	
9th ...	96	75	92	73.6	54.6	
10th ...	89	72	82	72.1	64.0	
11th ...	87	72	90	72.0	61.6	
12th ...	87	73	91	71.4	61.7	
13th ...	90	71	88	71.8	60.2	
14th ...	90	73	89	72.3	61.9	
15th ...	92	72	84	70.9	50.9	
16th ...	97	76	90	72.3	48.9	
17th ...	96	72	77	71.9	45.6	
18th ...	94	74	91	73.4	58.7	
19th ...	89	74	87	71.8	62.3	
20th ...	89	72	88	71.8	58.2	
21st ...	90	72	79	69.4	56.3	
22nd ...	89	75	87	72.2	63.4	
23rd ...	86	75	84	75.2	67.1	
24th ...	89	73	91	74.1	63.7	
25th ...	91	73	82	72.1	49.5	
26th ...	89	76	93	75.9	62.1	
27th ...	86	76	92	75.4	72.2	
28th ...	88	75	86	73.6	69.7	
29th ...	88	72	89	74.7	70.2	
30th ...	90	74	93	74.1	63.8	
31st ...	88	72	90	73.5	68.3	

TABLE I (continued)

Date	Max. Temp.	Min. Temp.	Highest Humidity	Highest Dew Point	Lowest Dew Point	Total Rainfall
AUGUST, 1951						
1st ...	86	70	83	71.5	64.5	Nil inches
2nd ...	88	71	82	70.8	61.7	
3rd ...	90	72	79	69.8	58.2	
4th ...	89	72	87	72.7	68.4	
5th ...	89	73	85	72.3	66.8	
6th ...	91	71	88	72.5	63.0	
7th ...	90	76	87	71.0	62.4	
8th ...	92	73	89	73.1	58.1	
9th ...	88	73	83	70.5	65.6	
10th ...	90	73	83	73.2	66.7	
11th ...	90	74	83	75.9	65.4	
12th ...	94	74	86	73.1	52.3	
13th ...	91	74	93	73.5	63.6	
14th ...	93	75	83	73.8	58.3	
15th ...	97	76	86	72.0	55.7	
16th ...	97	75	78	71.1	47.7	
17th ...	93	77	86	72.4	57.1	
18th ...	90	74	87	73.5	59.7	
19th ...	90	76	74	68.1	51.2	
20th ...	90	79	88	77.1	68.6	
21st ...	95	75	93	78.7	65.1	
22nd ...	94	78	95	77.9	68.8	
23rd ...	90	76	92	76.4	65.4	
24th ...	91	73	87	75.2	67.7	
25th ...	92	74	88	74.8	65.1	
26th ...	92	75	85	72.5	66.4	
27th ...	89	76	83	73.1	70.1	
28th ...	88	72	87	72.6	69.1	
29th ...	87	71	86	70.9	65.5	
30th ...	89	73	84	69.1	65.2	
31st ...	90	71	82	72.1	58.0	
SEPT., 1951						
1st ...	88	74	85	72.6	64.9	11.7 mm. (0.46 in.)
2nd ...	89	74	82	71.2	62.6	
3rd ...	89	74	92	74.0	61.2	
4th ...	87	71	84	71.6	61.4	
5th ...	84	77	90	76.5	63.6	
6th ...	90	82	96	78.7	73.7	
7th ...	87	72	82	75.0	66.9	
8th ...	90	73	91	71.6	52.1	
9th ...	87	72	82	72.1	57.7	
10th ...	87	67	87	68.8	58.0	
11th ...	84	75	81	69.3	58.1	
12th ...	85	74	87	74.5	68.0	
13th ...	88	72	94	77.3	65.0	
14th ...	93	73	99	76.8	54.6	
15th ...	90	75	97	76.9	69.6	
16th ...	89	77	91	75.4	72.3	
17th ...	88	79	91	75.5	71.6	
18th ...	87	79	88	75.9	72.0	
19th ...	87	76	91	76.7	69.3	
20th ...	87	74	92	74.0	58.4	
21st ...	83	69	77	66.2	62.0	
22nd ...	79	69	82	64.6	56.7	
23rd ...	80	69	64	59.6	49.8	
24th ...	79	65	69	61.0	54.3	
25th ...	80	65	74	59.7	54.2	
26th ...	81	72	74	62.7	51.5	
27th ...	84	69	82	70.7	57.3	
28th ...	83	66	85	69.4	52.5	
29th ...	84	74	90	72.4	60.4	
30th ...	86	77	89	72.1	68.4	



## METHOD

In each of four areas an extra issue of coal was arranged to three married quarters provided with the old type kitchen range and to one or more provided with a modern insulated Glowworm Stove.

The stoves were lit at 0800 hours and carefully stoked to provide maximum efficiency with regard to both hot water and oven temperature.

Instrument	Measurement	Observations at Locations		
Whirling hygrometer	°F. Dry bulb ... ..			
	°F. Wet bulb ... ..			
	Temperature difference ...			
Tables	% Relative humidity ... ..			
	Dew point ... ..			
Globe thermometer	G.T. °F. ... ..			
Kata thermometer, silvered 130–125° F.	Cooling time ... ..			
	Kata factor ... ..			
Normogram	Cooling power ... ..			
	Air velocity ... ..			
Normogram	Effective temperature °F. ...			
	Corrected effective temperature, °F. ... ..			
Normogram	Mean temperature of surround- ings, °F. ... ..			
Subjective thermal comfort sensations	Heat ... ..			
	Moisture ... ..			
	Freshness ... ..			

## External Conditions

## Shade Readings

°F. Dry bulb

°F. Wet bulb

Temp. difference

Relative humidity

Dew point

Remarks :

FIG. 1.—ENVIRONMENTAL CONDITIONS AND THERMAL COMFORT OBSERVATIONS

Appointments were made successively at half-hourly intervals from 1130 hours until 1300 hours, one day being devoted to each area in turn.

On arrival, the examining team, which consisted of the author and two hygiene assistants, set up their apparatus and adjusted ventilation in accordance with the usual practice of the housewife concerned, *i.e.*, if she was not prepared to bake or roast with the window open, it was closed ; if she showed no prejudice, the window remained open. In all cases the door leading from the kitchen to the living-room remained open wide, and the front door leading straight from the veranda into the living-room (which is common design in Malta) was wide open also.

The instruments used were those provided on Her Majesty's ships, *viz.*; (a) Globe thermometer ; (b) silvered thermometer ; (c) whirling hygrometer ; (d) high temperature silvered kata thermometer ; (e) stop watch ; (f) normograms.

The whole subject of the use of these instruments and the interpretation of results is dealt with in detail in M.R.C. War Memorandum No. 17, "Environmental Warmth and its Measurement" (H.M.S.O.). All that need be emphasized here is that, suspecting a dominant source of radiant heat to be one major cause of discomfort in these kitchens, it was decided to record the globe thermometer readings. These would, by the use of appropriate normograms, give a rough figure for the mean temperature of the surroundings, and the corrected effective temperature, which is a consolidated measure of all climatic components, *viz.*, air velocity, humidity, air temperature, and radiation.

A *pro forma* was evolved (Fig. 1) based almost exactly on that used in the Applied Physiology Department of the London School of Tropical Medicine and Hygiene. The data thereon cover the field of objective climatic observations and also provide a numerical record of subjective thermal comfort sensations. For this subjective record, the observers are asked to break down their impression of thermal comfort or discomfort into the components heat, moisture and freshness. The numerical equivalents of their sensations are as follows :

HEAT SCALE (a)			MOISTURE SCALE (b)			FRESHNESS SCALE (c)		
Sensation	...	Code	Sensation	...	Code	Sensation	...	Code
Hot	...	+4	Moist	...	+4	Very stuffy	...	+2
Too warm	...	+3	Too humid	...	+3	Stuffy	...	+1
Warm	...	+2	Humid	...	+2	Comfortable	...	0
Comfortably warm	...	+1	Comfortably humid	...	+1	Fresh	...	-1
Neutral	...	0	Neutral	...	0	Very fresh	...	-2
Comfortably cool	...	-1	Comfortably dry	...	-1			
Cool	...	-2	Dry	...	-2			
Too cool	...	-3	Too dry	...	-3			
Cold	...	-4	Parched	...	-4			

Inasmuch as the effective temperature scale is based on large numbers of subjective impressions it is interesting to correlate the subjective numerical equivalent with the corrected effective temperature arrived at by instrumental observation.

The globe thermometer was placed in a position which the housewife might

TABLE II.—SUMMARY OF FINDINGS

	IMTARFA			TIGNE			ST. ANDREW'S			ST. PATRICK'S		
	Old Type			Glow-worm			Old Type			Old Type		
	"A"	"B"	"C"	"A"	"B"	"C"	"A"	"B"	"C"	"A"	"B"	Glow-worm "B"
External Air D.B.T. ...	90	90	88	88	88	88	87	88	87	88	87	88
External R.H. ...	65	65	64	64	64	64	71	74	77	68	70	68
Kitchen D.B.T. ...	97	90	90	92	90	90	90	90	90	91	95	91
Kitchen W.B.T. ...	85	82	80	80	79	80	82	81	82	80	85	82
Kitchen R.H. ...	61	71	65	60	62	65	71	68	68	62	66	68
Kitchen Globe Temp.	103	101	97	99	103	—	112	96	96	103	98	95
Kitchen Air Velocity, f.p.m.	0	0	2	55	60	0	20	20	20	18	20	15
Kitchen Effective Temp.	89	86	84.5	84	82.5	84.5	84.5	84	85	84	82.5	85
Kitchen C.E.T. ...	91	88.5	86.5	86	86.5	—	90	86.5	86.5	87.2	84.5	86.5
Kitchen mean temp. surroundings ...	106	104	99	106	117.5	—	124	100	100	107	103.5	109
Heat Sensation ...	+4	+4	+3	+3	+2	+4	+4	+3	+3	+3	+4	+2
Moisture Sensation ...	+2	+3	+2	+3	+1	+2	+3	+2	+2	+1	+2	+1
Freshness Sensation ...	+2	+2	+1	-1	0	+1	+1	+1	+1	+1	+2	+1
Dimensions sq. ft. ...	80	80	72	120	120	120	126	126	84	120	120	100
H.W. Efficiency ...	Fair	Fair	Good	Excellent	Good	Excellent	Good	Good	Separate Fair	Excellent	Fair	Fair
Oven Efficiency ...	Poor	Fair	Fair	Excellent	Good	Excellent	Excellent	Good	Fair	Fair	Excellent	Fair

be expected to occupy most frequently when actively engaged in the kitchen, and it was allowed to "cook" for 20 minutes, the silvered thermometer which excludes the effect of radiation hanging beside it.

Whirling hygrometer readings were then taken in the same position and on the veranda externally in the shade.

The hygiene assistants took turns at timing the fall of alcohol in the kata thermometer. The author recorded the data, including sensation of operators, and worked out from the normograms, air velocity, effective temperature, and corrected effective temperature, and finally mean temperature of surroundings.

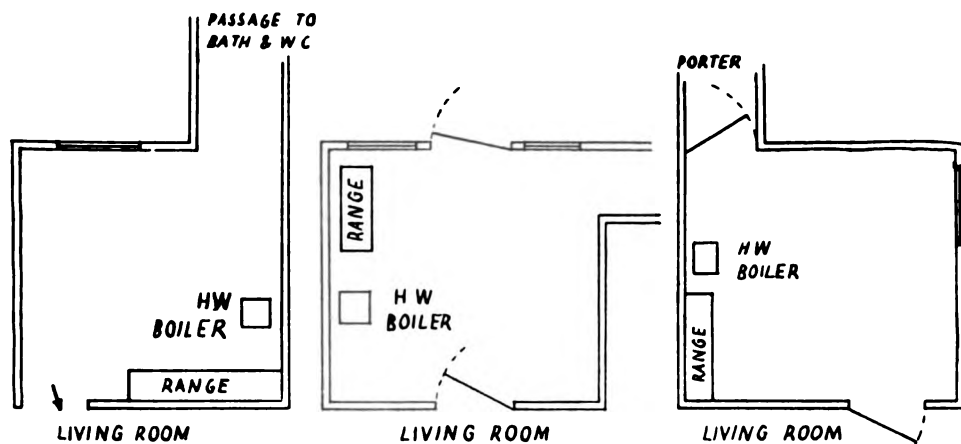


FIG. 2

The hygiene assistants thus suffered considerably more than the author and usually after the first appointment of the day emerged with sweat-soaked shirts. The housewife occasionally allowed her curiosity to overcome her discretion and was similarly discomforted. Two opportunists used the free issue to bake cakes, one to roast a joint, and all expressed their intention to bathe in the hot water (except one, whose hot water system was separate).

After twenty minutes the globe and silvered thermometers were read, and whilst the apparatus was being packed up the oven temperature was noted, the hot water tank tested and the kitchen dimensions measured, its shape being noted together with the positioning of the stove.

Summarized findings are at Table II.

#### DISCUSSION

*Climatic Conditions.*—During the four days of experiment, the external ambient was relatively stationary (86° F. to 90° F.). The relative humidity ranged from 61 to 77 per cent., the lower readings, by and large, being limited to the high ground at Imtarfa.

*Internal Design.*—Kitchens are all small when one bears in mind that

- (a) each quarter has only one moderate sized living-room ;
- (b) the kitchen might therefore reasonably be designated dining/kitchen ;
- (c) we are here dealing with a semi-tropical climate, whereas the Ministry of Health recommendation for a *working* kitchen only in *temperate* climate is 90 to 110 sq. ft.

The shape of the room affects materially the possibility of finding a comfortable working area out of range of direct radiant heat from the stove as the rough plans in Fig. 2 indicate.

*Validity of Subjective Impressions.*—At Table III correlations have been worked out between

- (a) subjective heat sensation and globe thermometer reading ;
- (b) subjective heat sensation and dry bulb temperature ;
- (c) subjective moisture sensation and relative humidity ;
- (d) subjective freshness sensation and air velocity.

No significant correlation appears to exist in the first three but, as might have been expected, there was a significant correlation between the air velocity records and the sense of freshness in the kitchen.

It then seemed not unreasonable to summate subjective thermal sensation with the figures recorded for heat, moisture and freshness and to attempt to correlate the resultants with corrected effective temperature in each case. As will be seen from Table IV, the result was highly significant.

If one dare comment upon these findings it might be to suggest that even with a strong source of radiant heat, one's subjective impression of temperature may be misleading ; that the dominant element in thermal sensation is the freshness derived from air velocity ; but, finally, that the subjective impression of the three basic elements of thermal sensations are very reasonably reflected in the single figure of corrected effective temperature, when radiant heat is dominant.

*Objective Data.*—The globe thermometer readings were in all cases in excess of the dry bulb readings, the difference ranging from 4° F. to 10° F. This is essentially an indication that the mean temperature of the surroundings—*i.e.*, walls, ceiling and floors, etc.—is greater than that of the air.

In the current experiment, the mean temperature of the surroundings was estimated from 100° F. to 104° F., and this figure was at no time less than 7° above the kitchen air temperature and 10° above the external air temperature. Thus it is not unreasonable to assume that radiant heat was a dominant factor in the sense of discomfort experienced. Since, however, the temperature of walls and floors was approximately that of the air temperature in the kitchen, it was evident that this radiant heat was centred in the kitchen range and adjacent hot water system. Whilst this conclusion is hardly startling, it is nevertheless objectively established.

TABLE III  
CORRELATION OF THERMAL SENSATION FIGURES TO CERTAIN OBJECTIVE DATA

Globe T	*Heat Sensation	Dry Bulb T	*Heat Sensation	Relative Humidity	*Moistness Sensation	Air Velocity	*Freshness
95	+2 (7)	91	+2 (7)	68	+1 (6)	15	+1 (4)
96	+2 (7)	89	+2 (7)	65	0 (5)	55	0 (3)
104	+3 (8)	96	+3 (8)	61	+2 (7)	20	+1 (4)
98	+4 (9)	95	+4 (9)	66	+2 (7)	20	+2 (5)
103	+3 (8)	91	+3 (8)	62	+1 (6)	18	+1 (4)
102	+3 (8)	91	+3 (8)	59	+1 (6)	35	+1 (4)
101	+3 (8)	91	+3 (8)	62	+1 (6)	35	+1 (4)
110	+3 (8)	90	+3 (8)	69	+2 (7)	20	+1 (4)
112	+4 (9)	90	+4 (9)	71	+3 (8)	20	+1 (4)
96	+3 (8)	90	+3 (8)	68	+2 (7)	20	+1 (4)
99	+2 (7)	88	+2 (7)	74	+2 (7)	15	+1 (4)
103	+4 (9)	97	+4 (9)	61	+2 (7)	0	+2 (5)
101	+4 (9)	90	+4 (9)	71	+3 (8)	0	+2 (5)
97	+3 (8)	90	+3 (8)	65	+2 (7)	2	+1 (4)
—	—	90	+4 (9)	65	+2 (7)	0	+1 (4)
99	+3 (8)	92	+3 (8)	60	+3 (8)	55	-1 (2)
103	+2 (7)	90	+2 (7)	62	+1 (6)	60	0 (3)
$\gamma = +0.43$ SE = 0.26 Not significant		$\gamma = +0.48$ SE = 0.25 Not significant		$\gamma = 0.3$ SE = 0.25 Not significant		$\gamma = -0.52$ SE = 0.25 Significant Negative correlation.	

N.B.—\*Heat, Moisture and Freshness figures have been converted to give a positive figure in all cases by starting at +1 instead of -4 or -2. (*vide* figures in brackets).

TABLE IV  
CORRELATION OF CORRECTED EFFECTIVE TEMPERATURES WITH SUMMED THERMAL SENSATION RECORDS

Corrected Effective Temperature	Sum. of Thermal Sensations
91	+ 8
85	+ 7
85	+ 8
86	+ 7
87	+ 5
87	+ 5
86	+ 5
86	+ 5
86	+ 4
84	+ 2
89	+ 6
89	+ 8
86	+ 7
86	+ 5
86	+ 3
$\gamma = 0.74$ SE = 0.27	Significant

*Effects of Heat.*—Clearly working conditions in these kitchens were intolerable. The experience of the author and his assistants vindicated the action taken by the occupants to provide their wives with more suitable cooking equipment.

It is noted that recent work at Singapore on thermal comfort showed that the large majority of men who had been living in a warship in the tropics for six months considered their environment reasonably comfortable if the effective temperature were 80° F. or less. In Malta temperatures of this order are not sustained throughout the year as they are in Singapore, so that tolerance, acquired after six months in relatively high effective temperatures, would be wasted in rapidly cooling late autumn conditions. During the 3—4-month period when high effective temperatures must be endured, tolerance has been lowered by the very cool winter and spring. Presumably, therefore, one is working from a lower baseline, and effective temperatures in kitchens of 82° F. to 89° F. are still *well* beyond the scatter of "reasonable comfort."

It is impossible to say what effect on health housewife duties in and out of the kitchen might have had during the period ranges would normally be lit, because the ladies concerned had, sensibly, never subjected themselves to trial. The author is dependent principally on M.R.C. War Memorandum No. 17 for information on endurable limits of temperature and the effect on working efficiency and safety.

Haldane found that the limits of endurance in still air at rest and *stripped* to be 88° F. wet bulb temperature and that this was reduced by 8° F. to 10° F. on moderate exercise. The W.B. findings in this experiment of from 79° F. to 89° F. might thus be considered, for women lightly clad, to be beyond endurable limits. Yaglou gives endurable limits for resting or light sedentary work as 90° F. effective temperature and as 80° F. effective temperature for heavy work. The effective temperature range in this experiment of 82° F. to 89° F. is surely at the endurable limit, particularly when one appreciates that effective temperature does not give weight to the radiant heat which dominated climatic environment in these kitchens. Without labouring the point, it is also reasonable to induce from industrial statistics that these working temperatures will not only reduce working efficiency but increase "accident proneness."

It is also hardly necessary to point out that, at the temperatures experienced, almost total reliance is placed upon the evaporation of sweat to maintain a constant body temperature. This evaporation is, of course, desperately hampered by trivial or absent air movement; and apart from the physiological embarrassment, it is sad and aesthetically displeasing to picture these housewives standing in great discomfort, with their clothes wetly clamped to their bodies.

*Outcome.*—As a result of the experiment the author submitted a summary of the data obtained (on the lines of Table II), and a brief description containing a firm statement that "both subjectively and objectively working conditions in all cases were unacceptable for comfort; in most cases were at or beyond the accepted limits of endurance; and, if endured, can be considered, without

doubt, detrimental to health." It was suggested that the components of this adverse environment were : (a) poor ventilation ; (b) low air velocity ; (c) bad design of kitchen ; (d) insufficient size of kitchen ; (e) excessive radiation from ranges, this factor dominating.

Without hesitation it was recommended that "coal fired ranges, whether of obsolescent or modern type, are quite unsuitable for routine cooking purposes in existing married quarters in Malta during the summer months, viz., from May to October."

This paper was then forwarded to higher authority as an appendix to a letter by G.O.C. requesting that as an interim measure an issue of oil cooking stoves and primus stoves be authorized to these quarters.

#### ACKNOWLEDGMENTS

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## PULMONARY TUBERCULOSIS: CERTAIN ASPECTS OF ITS PREVENTION IN THE BRITISH ARMY

BY

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#### INTRODUCTION

THE Army is a community which can influence the environment of its members to an appreciable extent. It also has the advantage of being able to control the entry into, and to banish undesirable members from, this community. None of these powers is absolute. It is often subject to the low environmental standards of adjacent communities ; undesirable qualities in candidates for entry are not always detectable ; banishment is a long process even when the defect requiring it is revealed. Tuberculosis in the Army will be considered in the light of these facts.

#### IMPORTANCE

This disease has never been important merely on account of its incidence alone. This has usually been lower than that obtaining in corresponding civilian groups and that for other infectious diseases in the Service. Its importance has depended on (1) its infectious nature ; (2) its chronicity ; (3) its tendency to relapse.



The first two factors raise difficulties in nursing and isolation.

The second two call for the repatriation of cases discovered abroad and raise problems in transporting infectious cases, particularly as few of them are fit for air transport and few ships are properly equipped for this duty. All factors have combined to require the patient's discharge from the Service.

### INCIDENCE

TABLE I.—INCIDENCE OF TUBERCULOSIS

Year	Incidence in the British Army (Males) per 1,000	Discharges in the British Army (Males) per 1,000	Incidence in the British Army in India (Males), per 1,000	Standardized Death Rates (Males), England and Wales	Formal Notifications (Males), England and Wales
1933 ...	1.2	1.07	0.8	0.707	31,633
1934 ...	1.0	0.94	1.0	0.648	30,747
1935 ...	1.1	0.86	1.0	0.608	28,117
1936 ...	1.0	0.96	1.1	0.581	28,077
1937 ...	1.1	1.02	1.3	0.577	28,475
1938 ...		0.97	1.2	0.534	27,813
1939 ...			1.1	0.539	25,355
1940 ...	1.2*	1.47	2.2	0.648	26,260
1941 ...	1.2*	1.68	1.9	0.712	28,966
1942 ...		1.08	1.3	0.664	29,560
1943 ...		1.06	0.9	0.724	30,121
1944 ...		1.20		0.702	30,044
1945 ...		1.11			29,124
1946 ...		1.50			29,003
1947 ...	2.16	2.58			28,879
1948 ...	1.40	3.13			28,863
1949 ...	1.06	2.77			28,981
1950 ...	1.21	2.00			

\* United Kingdom only.

### ANALYSES

Direct comparison of the civil with military rates is impossible for the following reasons :

#### (a) Incidence :

- (i) Diagnosis within the Service is more easily, hence more frequently, established.
- (ii) The military group is selected by mass miniature radiography (but see below).
- (iii) Army strengths fluctuate, so that it is virtually impossible to construct a standard population.

#### (b) Mortality :

By discharging its sick, the Service artificially reduces its mortality to vanishing point.

The post-war increase in the Army incidence rates is due to several factors, partly statistical and partly diagnostic in origin.

(a) Statistical :

- (i) Pre-war, the number of cases was assessed from a count of the Hospital Record Cards (Army Form I. 1220). The diagnosis, in this case, was confirmed. Post-war numbers are derived from a return of cases admitted to hospitals during the month (Army Form W. 3166), when the diagnosis, often tentative, is subject to correction.
- (ii) Cases which arose during the rapid decline in post-war strengths were usually correlated with a later, and lower, strength.
- (iii) Prisoners of war suffering from phthisis, who were released in 1944 or 1945, were accounted for in those years whereas they might have contracted the disease in previous years.
- (iv) The National Service Acts ensured that large numbers of susceptible young men were enlisted for short periods so that the Army, temporarily, was subjected to the conditions of civil life. The proportion of National Service men to Regulars in 1950 was 100/96.

(b) Diagnostic :

Mass miniature radiography was introduced at the end of the war (though not universally applied until 1947), to reduce the numbers of sub-clinical cases entering the Service. As the examination was then undertaken only after enlistment, the immediate result was to increase the numbers discovered within the Army. This factor is gradually being eliminated as the results of radiography are becoming available to the Ministry of Labour and National Service Boards which select men for service with the Forces.

The discharge rate, which is still compiled now in the same way as it was pre-war, shows a similar trend which is due to the same factors. The greater post-war increase is due to the policy of delayed discharge. Pre-war, a case of phthisis was discharged to civil life as soon as arrangements could be made for his reception. During the war it became increasingly difficult to arrange, so cases were retained within the Service. This policy caused a "pile-up" in the years immediately following the war and this was exaggerated by the released prisoners. The Service now provides special hospitals for these cases.

#### CONTROL OF THE DISEASE

With any disease, control measures, to be successful, must be based on a knowledge of its ætiology. Factors generally accepted as being important in the spread of tuberculosis are :

- (A) The infecting micro-organism (infection).
- (B) Nutrition.
- (C) Natural and acquired resistance.

(D) Other environmental factors.

(E) Administrative services and "real wages" (1).

Not all these factors are directly applicable to the Army.

#### (A) INFECTION

The Service has always emphasized the importance of this factor and has dealt with it by—

(I) Selecting only those deemed free from infection.

(II) Ensuring the early diagnosis of the case.

(III) Reducing the chance of barrack-room spread.

#### (I) *Selection*

Pre-war this was based on the history and a physical examination. It is doubtful if the former served any useful purpose as it was taken in the form of answers to a questionnaire, and the applicant soon realized that the correct reply to every question was "No." The physical examination was exhaustive and included careful chest measurements. This procedure was probably more effective in rejecting potential cases of pulmonary tuberculosis than unaided stethoscopic assessment of the chest. The limitations of the examination were tacitly admitted by the presence of a regulation which required each recruit to be weighed thrice during training and, if on any occasion he failed to gain weight, required him to be examined as a suspected case of phthisis (2).

Since the war mass miniature radiography has been introduced to cover this deficiency. All recruits are now so examined either before or immediately after joining the Service. The results of radiography on the 1949 "intake" are summarized below :

	Per 1,000
(a) Total number of recruits (including women) examined ...	1,000
(b) Number recalled for further examination ... ..	33.5
(c) Number adequately investigated by the end of the year ...	24.5
(d) Proportion diagnosed as tuberculous (active) ... ..	1.1
(e) Proportion diagnosed as tuberculous (inactive) ... ..	1.8
(f) Proportion diagnosed as "other disease" ... ..	6.5
(g) Proportion in whom no abnormality was detected ... ..	14.9
(h) Proportion who failed to complete the examination ...	9.0

The high proportion of persons who thus failed to complete their examination was due to the following causes :

- (i) Time factor (many completed their examination in the following year).
- (ii) The nature of the abnormality revealed by the miniature film. When this was known to be irrelevant—*e.g.*, missing ribs—some formations refrained from taking further action.
- (iii) Premature postings overseas.
- (iv) Clerical errors.

If it be assumed that the uninvestigated cases would have fallen into the groups in the same proportion as the fully investigated, the distribution becomes :

	Per 1,000
(b) Proportion requiring further investigation ... ..	33.5
(d) Proportion diagnosed as tuberculosis (active) ... ..	1.4
(e) Proportion diagnosed as tuberculosis (inactive) ... ..	2.3
(f) Proportion diagnosed as "other disease" ... ..	9.7
(g) Proportion in whom no abnormality was detected ... ..	20.1

The rate of 1.4 per thousand is much below that found in other surveys, *e.g.*,

Survey	Group	Date	Rate per 1,000	Size of Sample
Ministry of Health ... ..	All groups	1943-1949	3.8	4,000,000 (3)
Royal Navy ... ..	Males	1941	3.3	166,598 (4)
Civil Servants ... ..	Males, aged 15-25	1946-1948	6.8	4,123 (5)
Civil Servants (repeat X-ray) ...	Males, aged 15-25	1946-1948	4.7	2,531 (5)
Young Adults ... ..	All groups	1934-1945	5.0	10,000 (6)

The difference can be explained partly by :

- (a) The preliminary selection of the Army group; those who were radiographed in the Service would have been examined twice.
- (b) The inclusion of the higher age groups in the Royal Naval and Ministry of Health groups.
- (c) A high infection rate in H.M. ships, Civil Service offices and hospitals.
- (d) Persons whose names are on the Tuberculosis Register are reported by the Medical Officer of Health of their district to the Ministry of Labour and National Service before their "call-up." This procedure ensures that these men are critically examined.

The precise significance of the tuberculin reaction is still in doubt. It is generally agreed that its presence indicates—(a) past infection; (b) either recent infection or unhealed infection (7); and its absence the reverse, though it is known that "reversion" may occur in persons who have escaped repeated reinfection even though an X-ray of the chest reveals undoubted, though healed, tuberculous lesions (8). In a survey in Tennessee this phenomenon was found in 24.5 per cent (9). McDougall (10) believes that this loss of sensitivity does not necessarily imply a loss of immunity. Myers (11) believes that a reaction may indicate the likelihood of future active disease. Some evidence that non-reactors fare better, in a "normal community," than reactors is given by the following surveys :

- (a) Of 1,002 soldiers, 575 were found to be reactors at the beginning of their service and 427 non-reactors. Within the observation period of six years, 8 per cent. of the originally tuberculin-positive group had developed clinical tuberculosis as compared with 4.2 per cent. of the non-reactors (12).

- (b) Of 800 school children having calcified lesions, 3.7 per cent. developed pulmonary tuberculosis within five years. Of 400 who were tuberculin-positive, but without radiological signs, 0.7 per cent. developed the disease within the same period. Of 500 who were negative both to X-ray and to tuberculin, 0.22 per cent. developed the disease (13).
- (c) The Prophit Survey results disagreed with these. In it the reactors suffered only one-third of the morbidity of the non-reactors. However, this trend was reversed in the case of the controls and was more than one-half in the case of the Navy boys, that is, among those not exposed to repeated infection. Also, none of the naval cases occurred during Survey observation, but presumably afterwards while under active service conditions. The other groups worked in the highly infected surroundings of hospitals (14).

While up to the present the Army has found it administratively impossible to test all recruits in this way, one believes that tuberculosis could be excluded with the reactors, provided always that the service environment remains as it is. A survey (15) recently undertaken by the Army for the Medical Research Council showed the following results :

(a) Number tested	...	...	...	5,130
(b) Number positive to 1 I.U. O.T.	...	...	...	2,294 (44.7 per cent.)
(c) Number positive to 100 I.U. O.T.	...	...	...	1,121 (21.9 per cent.)
(d) Number negative	...	...	...	1,651 (32.2 per cent.)
(e) Doubtful	...	...	...	64 (1.2 per cent.)
(f) Tests incomplete or refused	...	...	...	67
(g) Number with normal X-ray	...	...	...	5,085
(h) Number with tuberculous lesion (active) and positive tuberculin reaction	...	...	...	5 (incl. 1 at 100 I.U.)
(i) Number with tuberculous lesion (in- active) and positive tuberculin reaction	...	...	...	10 (all at 1 I.U.)
(j) Number with tuberculous lesion (in- active) with negative tuberculin reaction	...	...	...	3
(k) Number tested but not X-rayed	...	...	...	34

Until the proportion of non-reactors among the young of the country rises considerably, any question of excluding reactors is of academic importance only, because of the numbers required. It may become practicable when its counterpart in cattle has succeeded in freeing our herds from tuberculosis.

## (II) *Early Diagnosis*

(a) In many walks of civil life, a person suffering from active phthisis may be fit enough to continue his work—and, incidentally, infect his associates—and be unconscious of any disability. This state is rarely possible under service conditions. Work, physical training and organized games would rapidly give rise to symptoms. Even if these were disregarded by the patient, signs of

physical deterioration would soon be noticed by his officers and instructors. Communal life also puts a man under the constant supervision of his fellows, who rarely seem to fail in taking appropriate action when their suspicions are aroused. Close medical supervision, also, is exercised in observing the men about their work and play as well as at formal inspections, inoculation parades, etc. Once suspicion is aroused, the man can be admitted to hospital while investigation proceeds, and he can even be isolated before the diagnosis is established. Regulations (16) prescribe steam disinfection of fomites (or formalin or cresol disinfection when the use of steam is contraindicated), and local disinfection of the barrack-room and place of work by scrubbing with  $1\frac{1}{4}$  per cent. cresol in water.

No specific instructions require the surveillance of contacts, but even pre-war it was customary to check these by weighing and physical examination each month for six months. Nowadays, where possible, it would be usual to examine them by M.M.R. Regrettably this is rarely available and never overseas. Full plates of a few special individuals may be taken, but often even this course is impracticable.

(b) *Tuberculin Sensitivity*.—It would seem that this is an ideal opportunity for using the Mantoux test on all contacts. The non-reactor, who remains so after the incubation period has elapsed, is more certainly free from active infection than if he had been fully investigated (17). One can expect this group to form at least one-third of the normal Army sample, and this proportion may be expected to rise owing both to reversions within the relatively tuberculosis-free service environment and to a declining risk of infection in civil life. Within this group, conversion can be considered as a sign of infection (18) and an increase in sensitivity as one of possible infection. On the other hand, known reactors, who have either lost or reduced their sensitivity in the relevant period, are most unlikely to have acquired a recent infection. This method of investigation should be possible for a Regimental Medical Officer to effect, if dry sterile syringes and tuberculin can be supplied. By doing so it should be possible to reduce considerably the number of contacts of whom further investigation is necessary. Further, if an unusually small proportion of non-reactors was found, a wider survey might indicate other sources of infection.

(c) *Mass Miniature Radiography*.—Both the Royal Navy and Royal Air Force use this method more often than at entry only. With the Army's greater strength, its scattered distribution and the fact that its M.M.R. units are fully employed in radiographing the new intakes, it has been found impossible to institute a further routine examination. Unfortunately, although the civilian M.M.R. units now radiograph a considerable proportion of the National Service "intakes," they operate on a regional basis which is not coincident with the Army's deployment of these men. Because of this, it will be impossible to release Army units for other tasks until only a small proportion of the intakes have not been radiographed by civil units and these can be posted to areas in which an Army unit operates.

**(III) Reducing Barrack-room Spread**

This measure is directed against all upper-respiratory infection and includes :

- (a) Adequate ventilation.
- (b) Avoidance of local overcrowding.
- (c) Preventing dust.
- (d) Disposal of fomites.
- (e) Education.

(a) Ventilation depends mainly on adequate spacing. New barrack schedules allow 70 square feet and 595 cubic feet per bed, also rooms are to hold either four or eight men only. Existing scales allow 60 and 600 respectively, but more men are housed in larger rooms. Air exchange is probably adequate when windows and doors are closed, but instructions require them open whenever weather permits. The bed space (six feet between centres) (19) is probably sufficient to limit direct droplet spread.

(b) With the old scales of few lighting points and fewer heating points, local overcrowding around the points was common, as was the spread of upper respiratory infections. This was demonstrated when, among troops engaged in snow-clearance and coal-haulage during the cold winter of 1947, in spite of fuel lack, huddled accommodation and, often, insufficient drying facilities, sick-rates fell, presumably because men went to bed to keep warm instead of crowding round a stove. The new scales have legislated for this fact by specifying an improved lighting standard, central background heating and open fires in "sitting rooms." These features and improved institute facilities should limit local overcrowding.

(c) Dust prevention has recently been shown to be an important factor in preventing cross-infection in hospitals (20). Regulations (1938) specified the dry sweeping of barracks as a major factor in the spread of tuberculosis (21). The importance of its prohibition is indicated by the frequency with which outbreaks of respiratory infection follow its neglect.

(d) Instructions forbid the interchange of clothing, blankets, pillow-slips, sheets and cutlery without preliminary appropriate cleansing. Special attention is paid to introducing efficient methods of washing communal crockery and cutlery, mainly to reduce the incidence of gastro-intestinal disease but, incidentally, of the respiratory. Soldiers are also encouraged to expose their bedding to the sun whenever possible.

(e) Health talks and films stress the personal method of reducing infection.

**(B) NUTRITION**

Pre-war the Army was fed on a complex system of allowances and issues against repayment both by the R.A.S.C. and by N.A.A.F.I. This had the virtue of variety and the calorie value was estimated as between 3,600 and 4,000. The standard depended mainly on the attention the unit paid to its "housekeeping." During the war full rations were issued, and this system with the addition of a

small "ration cash allowance" has continued. This system allows for little elasticity, but on the other hand restricts maladministration. Unfortunately the calorific value is less. A survey undertaken within the Army in 1947-8 showed the following facts :

- (i) About 11 per cent. of the ration was wasted in distribution, cooking and serving.
- (ii) The calorific value of the official ration formed only about 75 per cent. of the soldier's requirements.
- (iii) The soldier more than adequately made good this deficiency at his own expense.

The survey considered that the soldier's needs would be satisfied by the following scales :

Type of Work						Net Calories
Light	...	...	...	...	...	3,200
Moderate and hard	...	...	...	...	...	3,600
Very hard	...	...	...	...	...	4,000

The present service ration is based on the civilian ration and is subject to similar, though not to such frequent, variations. The deficiency between the average soldier's requirements and the calorific value of the ration continues to be made up at his expense. The Service strives to minimize the loss by maintaining a high catering standard, by providing convenient kitchens, and by avoiding wastage, *e.g.*, replacing unskilled potato-peeling by hand by machines. In spite of this, and because civilian institutional catering standards have risen, Army catering has lost the lead it once held.

### (C) RESISTANCE

(i) *Natural*.—There is still a real danger that natural resistance to tuberculosis can be over-emphasized to the lay person so as to conjure up the bogey of hereditary and inevitable disease in his mind. This makes him unable or unwilling to accept its essentially infectious nature. Nevertheless, natural resistance or susceptibility has been observed. Kallman and Reisner (22), after studying the incidence of tuberculosis in uniovular twins, concluded that "The chance of dying from tuberculosis is practically zero for a tuberculosis patient who is the monozygote twin of a person who remains free of tuberculosis despite exposure to infection." This fact has little significance to the Service, but the findings of the Prophit Survey that Irish and Welsh nurses in London hospitals suffer a significantly higher morbidity than English irrespective of whether they were tuberculin reactors or not on entry (23) is of interest. Pre-war, a high proportion of the Army was Irish and this was particularly true of the medical and nursing services. It is probable that a high proportion were non-reactors. That few developed clinical tuberculosis is presumably due to the low infectivity of their service environment. This predominance no longer obtains.



(ii) *Acquired*.—(a) “There remains little doubt that in most circumstances the risk of young adults developing tuberculosis is less in those infected at some time in the past than in those not previously infected and now infected for the first time. It is necessary to add that this difference in morbidity has been clearly demonstrated only in groups known to be exposed. It does not follow that the difference would be observed, or be of the same magnitude, in groups undergoing less exposure. The risk bears particularly on the years following primary infection” (24). This phenomenon could be explained by assuming that primary infection induced both a rapidly acquired sensitivity which waned over the first few years, and a more slowly acquired immunity which waned equally slowly. The finding of the Prophit Survey that the morbidity rate among those nurses originally tuberculin-negative was high in the first year and low in subsequent years, and that the reverse was true among those tuberculin-positive on entry (25), appears to support this view. Willis (26) has shown that animals which have lost their hypersensitivity retain their resistance to reinfection in high degree. A survey among Africans in the Rand gold mines showed that the higher the degree of allergy the greater the risk of developing tuberculosis (27). These observations also appear consistent with this theory.

(b) The Army has recently introduced B.C.G. vaccination on a voluntary basis for all regular R.A.M.C. other ranks and all members of Q.A.R.A.N.C. No officer or other rank R.A.M.C. who specifically requests the vaccination will be refused. Vaccination will be given only to those of the above categories who are also non-reactors to 0.1 ml. (100 International Units) of Old Tuberculin. Separate needles and syringes are prescribed for each dilution of tuberculin and for the vaccine, and these will be autoclaved. Records of each vaccination and its results, described as to the state and size of the reaction and as to the presence of abscess or glandular enlargement, will be kept. Retesting for Mantoux conversion is required after six weeks and, if negative, the procedure will be repeated after a further six weeks. Annual retesting for sensitivity will be performed.

#### (D) ENVIRONMENTAL FACTORS

The relevant accommodation standards have been considered in connection with infection. Beyond these, it is realized that amenities are necessary if the young soldier is to be discouraged from leaving barracks to find them, often under insanitary surroundings. This factor is most important in countries which have a high rate of tuberculosis infection, *e.g.*,

Country		Incidence per cent.	Mortality per Million
Hong Kong	...	2.3	— (28)
Singapore	...	—	2,500 (1938) (29)
Egypt	...	3.0	1,500 (30)
Jamaica	...	2-6.0	640 (31)

The real rates are probably even higher. In the first two places, the custom of providing professional partners in dancing halls materially increases the risk.

Amenities include barracks sited in pleasant surroundings, preferably about a mile from towns, institutes which cater for most tastes, and adequate playing fields.

#### (E) ADMINISTRATIVE SERVICES

In the Army a comprehensive medical service provides both treatment for disease and a true health service. The latter includes routine medical examinations, inoculations and vaccinations, health education, and medical supervision over all activities.

Since the war the idea of "positive health," as opposed to the mere absence of disease, has been popularized. This, shortly, seeks to encourage the individual to want to keep himself in the highest possible state of physical fitness, and enters the psychological field and is closely allied to morale. Though the question of "positive health" and morale is of great importance, their implications are too wide to be considered in this paper.

#### SPECIAL GROUPS

Certain service groups are exposed to a high degree of infection. These include medical personnel, those working with civilians or "overseas troops" and those married to tuberculous wives.

##### *Medical Personnel*

Medical personnel, coming into contact with tuberculosis, are selected by physical examination, radiological examination, bacteriological examination and tuberculin testing. Only those tuberculin reactors showing either radiologically clear chests or evidence of healed lesions are employed. The examination, less tuberculin testing, is repeated quarterly and when the tour of duty is completed. B.C.G. vaccination is offered to non-reactors.

Precautions on the lines of those practised in London hospitals are enforced. These include education of orderlies and nurses, education of patients and ward precautions.

The aspects stressed in the education of staff are :

1. Infection is controllable.
2. Proper disposal of fomites.
3. The danger of fomites, sputum, saliva and dust.
4. The danger of eating in tuberculosis wards.
5. The need to control their patients' coughing.
6. The need to keep their hands free from infection.
7. The need for adequate rest and leave.
8. The need for taking regular outdoor exercise.
9. The need for avoiding common infections.
10. The need for reporting even minor degrees of ill-health urgently.

Patients are taught that—

1. Coughing spreads the disease to others.
2. Coughing aggravates their condition (by distending cavities).

3. Coughing is controllable.
4. Sputum, saliva and articles soiled with these are dangerous and should be controlled to avoid others being contaminated.

Ward precautions are taken regarding the following :

1. Sputum pots will be handled only with gloves and incinerated.
2. Gowns or white coats will always be worn.
3. Masks will be worn when nursing patients who cannot control their coughing. They will not be reversed nor be used in a way that allows this, *e.g.*, putting in pockets.
4. Dry sweeping is forbidden ; vacuum cleaning is desirable.
5. Bed linen must not be agitated, either when making beds or when sorting.
6. Ventilation must be adequate. Patients will be nursed on verandas if possible.

Nurses and orderlies are now permitted to work on tuberculosis wards indefinitely. The previous system of limiting the period to six months was abandoned when it became apparent that the rapid change produced an untrained staff who were a danger to themselves as well as being inefficient in their duties.

### *Contact at Work*

The risk is appreciable to the young clerk working under cramped conditions with others locally recruited in a country with a high infection rate. Usually, the latter are examined only physically. Segregation is the only practicable solution until M.M.R. makes repeated radiography of employed civilians possible. A similar risk from elderly civilian clerks in this country has been almost eliminated by this method. Domestic servants constitute a minor risk to the soldier but, indirectly, through his family, this risk becomes serious. Contact is limited as much as possible, but repeated M.M.R. is desirable.

### *Marital Tuberculosis*

This requires treatment similar to the case in civil life. Many of the problems, *e.g.*, re-housing, are solved more easily. Open cases would not be allowed to proceed overseas.

### SUMMARY

The control of tuberculosis in the Army has been considered with particular reference to the reduction of infection.

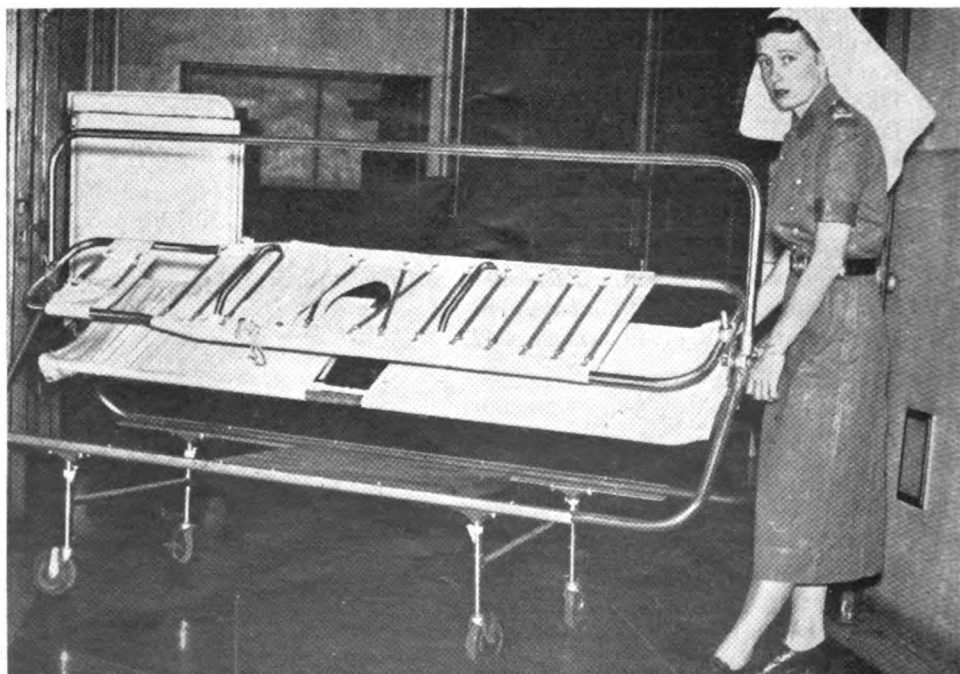
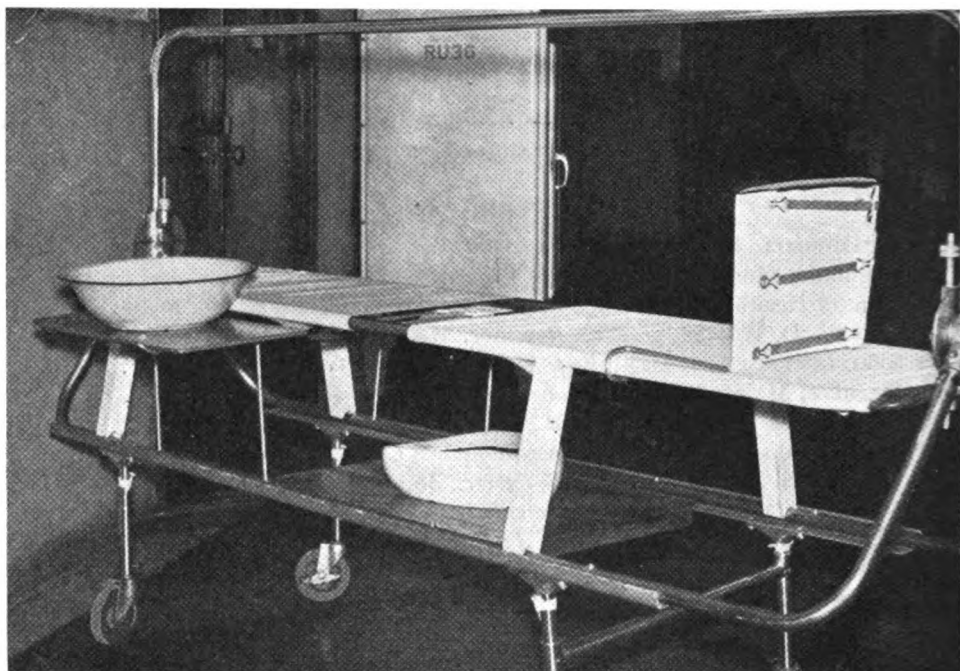
The problem of excluding the infected recruit has been traced from the pre-war rejection of the clinical case by physical examination, through the present phase of rejecting the sub-clinical case by radiography, to the possibility of excluding infection in the future by excluding all tuberculin reactors. The prompt detection of cases arising within the service is examined in the same light.

The place of resistance, nutrition, environment and positive health in the aetiology of the disease is mentioned.

The protection of certain groups who are specially at risk and the reduction of chance infection in general are examined.

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THE STRYKER FRAME

## THE STRYKER FRAME

BY

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THE care of paraplegics has always been a major nursing problem ; many methods have been used, but most of these are difficult, complicated and time consuming. When, in 1937, an American, Dr. Homer Stryker of Michigan University, developed the Stryker frame he solved many of these nursing problems, and the U.S. Army and Naval hospitals proved its worth during the 1939-1945 world war. Today, American, British and other U.N. forces in Korea and Japan are using it with great success.

Among the many problems which confront the nurse when looking after a paraplegic are the prevention of bedsores, hypostatic pneumonia, and venous thrombosis. The Stryker frame, while not wholly eliminating these complications, simplifies their management, and does away with the heavy labour associated with the nursing of a paraplegic in a plaster bed.

Since its introduction, the frame has been found eminently suitable for, and has greatly simplified the nursing of, some severe accident cases and battle casualties ; for example, extensive burns, large suppurating wounds, and patients with incontinence.

The Stryker frame consists of eight principal parts (see next page).

1. The standard frame trolley (Fig. 1). This tubular frame with four up-rights and running on four swivel wheels forms a conveniently sized oblong. Fitted to the four uprights are two runners (Fig. 1A) to hold the Stryker turning frame.

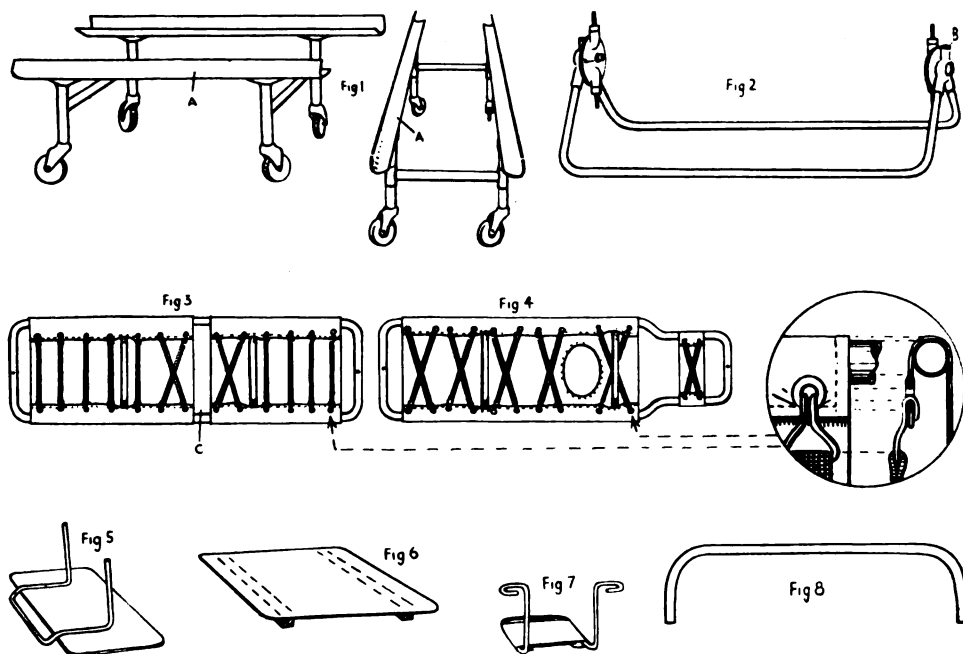
2. The Stryker turning frame. This consists of two tubular, triangular-shaped ends, joined together by two tubular supports (Fig. 2). At the apex of the triangle is a pivot pin and the pins for the attachment of the anterior and posterior frames.

3. The posterior frame. This rectangular tubular frame has a canvas cover which is kept evenly taut by the use of rubber fasteners (Fig. 3). The canvas is split in halves for toilet purposes (Fig. 3c).

4. The anterior frame. Similar in shape and size to the posterior frame, it has a short canvas cover with a perineal opening (Fig. 4). Also fitted to the anterior frame is a "headpiece." This consists of a 4-inch to 6-inch strip of canvas covered with lint or cotton wool (Fig. 4). The forehead rests comfortably on this padded strip of canvas for over two hours.

5. Two arm supports. These are made of planed wood with metal rod attachments which fit into holes in the tubular supports of the Stryker turning frame (Fig. 5).

6. The platform tray or trays. These are planed strips of wood of such dimensions that they slide along the tubular supports of the base of the turning frame. These support a bed-pan when necessary and also act as a table when the patient is lying on the anterior frame (Fig. 6).



7. The foot support consists of squared, shaped steel rods which are covered with canvas, which is kept taut by the use of rubber fasteners. The support is clipped over the posterior frame and can be held in position by straps (Fig. 7).

8. The overhead frame (Fig. 8). This tubular frame fits into holes at the apex of the triangle of the turning frame (Fig. 2B).

The nursing care of the patient on a Stryker frame follows the rules set down for the nursing of any patient. However, with the frame, it is common practice to turn a patient over every two hours. This practice will depend somewhat on the patient's diagnosis and condition. In some conditions the patient is permitted to sleep on the posterior frame during the night, his position being changed every two or four hours during the day.

The technique of manipulation of the frame is simplicity itself. One or

preferably two nurses are required for the procedure, and for the purpose of illustration the patient is lying on the posterior frame, *i.e.*, on his back.

To turn him over, pillows are placed over his legs and body, up to and including the chest. This helps to secure the patient, and also gives him something soft and comfortable on which to lie. The anterior frame is then placed on the pivots and the nuts screwed on securely.

If the patient has control of his arms, he places them round the anterior frame. If his arms are badly burnt or paralysed, they are tucked well into his sides, care being taken that his arms are firmly secured, and before he is turned the nurse makes sure that he cannot slip during the movement. The patient should be instructed as to which way he will be turned.

The two nurses then stand at either end of the frame and each with her right hand pulls out the two spring locks, meanwhile steadying the frame with her left hand. The patient is then turned, and when the spring locks have sprung back into position and have been checked, the posterior frame and pillows are removed. Bed-clothes are now replaced. These can either be placed over the patient and left hanging over the sides of the bed, or they can be hung over the overhead frame and draped on either side of the patient. Experience has taught me that the majority of patients prefer to be turned over quickly, as this eliminates the giddiness sometimes felt when being turned over slowly.

Transportation of the paraplegics has always proved a problem, and the frame provides the ideal answer. Comparatively small, and easily portable, the bed is simply wheeled to the X-ray Department as required. If it becomes necessary to move the patient to another hospital, the frame, less the trolley, slides easily into an ambulance or train.

Like many other methods or inventions, the frame will have its critics, but its usefulness cannot be denied, and in my opinion there is no doubt it will find its place in all hospitals as an indispensable adjunct to the nursing of paraplegics.

#### SUMMARY

I have attempted to give a brief review of the Stryker frame, a new method of nursing paraplegics widely used throughout the U.S.A.

I strongly advocate its wider use in the British Isles as a new and better method of nursing paraplegics.

A similar turning frame is made by the Medical Supply Association, Ltd., in England.

#### ACKNOWLEDGMENTS

I should like to thank Lieut.-Colonel D. Wright, D.S.O., and Major V. M. Innes, Sister Tutor, for their unwavering help and criticism; Mr. W. G. Cook, for his diagrams; Mr. E. P. Hodges for his help in the preparation of this review in its early stages; and to Brigadier F. J. O'Meara, D.D.M.S., H.Q. B.C.F.K., for permission to publish the article.



## ACUTE NECROSING MYOSITIS

BY

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DURING the month of March, 1952, six Mauritian Pioneers were admitted to the surgical ward of the Station Hospital, Mauritius, with very similar histories and clinical findings presenting great difficulty in diagnosis. All cases had acutely painful swellings: three of these extended the whole length of the thigh, one involved the calf, one the shoulder region, and the last was a localized swelling 2 inches long on the medial side of the thigh just above the knee.

Two came with histories of having been bitten by insects, one specifying a big black fly. The other four all gave a history of injury; one had been kicked at football, one had fallen off a bicycle, one had twisted his leg, and the fourth had been knocked.

On examination they were all obviously ill. Their temperatures ranged between 100° F. and 103° F. The swellings were hot and tense, with ill-defined borders. No regional adenitis was present. White blood counts carried out on all cases showed a polymorphonuclear leucocytosis up to 20,000 per c.mm. Blood cultures in three cases were carried out, and found to be sterile. X-rays showed no bony changes or gas in the tissues.

The swellings were not fluctuant, but as the possibility of deep abscesses could not be discarded and as there was great tension of the tissues, it was decided to operate on them. When the deep fascia was cut, the muscle bulged through the incision and was extensively necrosed. The dead cheesy tissue was swabbed away. In the three most severe cases, in which the thighs were affected, there was sloughing throughout the whole length of the vastus lateralis in one case and adductor group of muscles in the other two cases. The wounds were left open and packed with vaseline gauze. In one case primary suture was carried out as the degree of necrosis was slight. Anti-gas gangrene serum was given to the first case and penicillin to all of them. Their temperatures settled slowly and secondary suture was possible two weeks later.

Swabs were taken at operation in four of the cases and cultures from these were sterile both aerobically and anaerobically. Histology was carried out on the material obtained at operation in three of the cases and showed only necrotic muscle.

The true cause of the necrosis was difficult to elucidate, but as the two initial cases said they had been bitten by insects a form of angioneurotic œdema was suspected. Benadryl was given but with no effect. The history of injury in the other cases suggested a hæmatoma, but as we found at operation it was the

muscle itself that was affected. Acute osteomyelitis was not the cause as the bone was not involved in any of the cases. The condition described as acute suppurative myositis was thought unlikely because of the absence of prodromal symptoms, the failure to find any causative organisms, and it seemed beyond the realm of possibility that we should have six cases of such a rare disease. It was only when the last three cases were admitted in quick succession that we became suspicious that a noxious agent might have been injected. With this in mind the patients were carefully questioned. They were all new recruits and three of them made statements that another soldier had told them that he could prevent them from going to Egypt by injecting their muscles, and that they must report to the hospital the next day with a feasible story.

At the court-martial that followed two of the patients stated that the substance injected was crude paraffin ; the third professed ignorance and the prisoner innocence. As one of the patients stated that he was drunk while the injection was being made, proof was only forthcoming on two out of the three charges, and the sentence was six months' imprisonment and ignominious discharge from the service.

The cases were of interest not only from the problem of diagnosis, but also because they show the severe toxic effects of the injection of crude paraffin leading to muscle necrosis.

My thanks are due to Dr. M. Alms, F.R.C.S., Orthopædic Surgeon, for his great assistance in treating the patients ; to Dr. F. Darne, F.R.C.S., and Captain E. R. Huehns, R.A.M.C., for helpful advice and criticism ; and to Major R. W. Doy, R.A.M.C., Officer Commanding, Station Hospital, Mauritius, for permission to publish the cases.

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## **SOME THOUGHTS ON THE RECRUITMENT OF MEDICAL OFFICERS**

BY

**Lieut.-Colonel R. M. HECTOR**  
*Royal Army Medical Corps*

At a time when things do not seem to be going too well for the Corps, many people within it must be wondering what are the causes and remedies, and it is not unlikely that a number are debating the question of quitting or staying on in the hope that our more obvious deficiencies will be made good.

Of equal or greater importance to the problem of attracting recruits is the one of satisfying those already in the Corps ; the snags of a service career are

not fully appreciated by the former on joining and therefore any noted by the latter should be eliminated where possible for the benefit of posterity. Unfortunately, the vast majority of improvements which could be carried out are beyond Corps control, but they are discussed as their introduction is considered necessary and urgent :

1. *Hospitals*.—The need for the replacement of our temporary and out-dated permanent hospitals is so obvious and well known that it hardly requires mention. Yet in spite of the rearmament programmes of two World Wars, not a single permanent hospital was built in Great Britain. Let us hope that the current rearmament programme will produce some permanent hospitals and not just a series of plans for their construction. The temporary type of hospital, *e.g.*, Waringfield, however well run, is so unsatisfactory in design and structure that a short spell of service in one of them helps the N.S. officer to make up his mind very quickly that the Corps is no place for him to spend a career ; to expect him to think otherwise is tantamount to asking him to accept a lower standard of working conditions than has been his wont. It is appreciated that the N.H.S. also has need of new construction, but their problems are not the same as ours—in particular they do not suffer from a shortage of recruits.

2. *Pay*.—It is difficult to understand why R.A.M.C. pay rates should be so closely related to those of the infantry and other arms. The cost of medical education, now extending over a period of almost seven years, has to be considered along with the free eighteen months' training period of Sandhurst cadets who actually receive pay while undergoing training. In the United States Army regular medical and dental officers receive 100 dollars (£35) per month over the basic pay and allowances, the latter being tax free. Recently a Senatorial sub-committee was appointed to consider the necessity for continuing this policy, and it was interesting to note that one member of the Armed Forces Medical Policy Council stated in evidence that the additional \$100 were necessary as a matter of equity and not simply as a recruitment inducement ; he added that although sixteen years had elapsed since he qualified as a doctor, he was still paying back a sum of \$35 per month to defray the debt he incurred for his medical training ; many people must be similarly placed in Britain today. It has also been estimated that were two individuals to embark on a career in the U.S. Army, one as a doctor and the other as an infantry officer, the latter would have received about \$40,000 more than the former by the time thirty years had elapsed since they began their respective trainings, assuming that each had drawn only the basic pay and allowances appropriate to their rank and service. It was on the basis of this argument that the figure of \$100 was decided upon.

Great discrepancies exist between our pay rates and those of the N.H.S., and these have been further accentuated by virtue of the recent Danckwerts Award. Furthermore, our more senior specialists have no opportunity of receiving a Merit Award, which places them in a most invidious position *vis-à-vis* their civilian colleagues ; the result is that a Brigadier grosses less than

half that of a civilian specialist who draws a maximum Merit Award. It is not to be wondered at when the younger specialists leave the Corps, although there are other reasons why they should. In these difficult times it is considered that our pay rates should slightly exceed those prevailing in the N.H.S. in both general and specialist categories. The highest bidder is undoubtedly going to come off best; in these days people have to be paid to take risks and to swallow or sublimate the inconveniences of a service career. Risk-taking is just not encouraged in this era of over-insurance.

3. *Allowances*.—Until very recently R.A.M.C. officers were specifically excluded from the regulation permitting officers with Staff College qualifications to receive Qualification Pay. For a Lieutenant-Colonel, R.A.M.C., to be able to draw Entertainment Allowance he must command a hospital of not less than 400 beds, plus the staff to run them, *i.e.*, about 600 all ranks or more, as a minimum. An infantry or other combatant officer of the same rank requires to command only 400 all ranks. The R.A.M.C. officer has therefore to command 50 per cent. more troops to qualify for this allowance. Clearly he is being discriminated against, as he was for many years in the matter of Qualification Pay. It would appear that officers in command of any hospital or field unit should receive Entertainment Allowance, as entertainment plays an important part in the smooth running of a unit, especially if it is located in a remote place and if Q.A.R.A.N.C. officers are on the strength. Personal entertainment by the Commanding Officer and his wife cannot be replaced by Mess entertainment entirely.

4. *Pensions*.—The U.S. Army gives retired officers retired pay at the rate of  $2\frac{1}{2}$  per cent. per year of service for twenty years or over, calculated at the highest substantive rank attained. An officer retiring after thirty years' service therefore draws  $30 \times 2\frac{1}{2}$  or 75 per cent. of the basic pay rate of the rank attained. This is much more generous than the terms offered to us. It is also interesting to note that in the event of death while serving, a sum of \$10,000 is paid to the dependant in addition to a widow's pension. Some form of insurance has been talked about for many years, on a similar basis, and is surely clearly indicated. Both widows' pensions and officers' retired pay are in urgent need of a boost, and after this has been done it would appear reasonable to relate them to the cost of living index.

5. *Specialists*.—One of the more evident shortcomings of our present organization is the necessity for a large number of specialists to give up practising their art at their prime in order to take up administrative appointments, just at the time when they are rendering their maximum therapeutic good to the community. A metaphorical pistol is gently held at the head and the words "Administer or retire" are uttered. Many foresee this untimely end to their professional careers, and retire earlier rather than later so that they can gain a foothold in the N.H.S. while still young enough to do so. This is without doubt a gross waste of highly trained and experienced medical personnel.

The solution is therefore to offer a thirty-year career as a specialist so that he can attain at least the rank of full colonel by time promotion and perhaps selection for higher consultant vacancies. Many people must fight shy at the thought of the possibility of a sudden end to their professional careers in the R.A.M.C. and so choose something different. It is appreciated that in time of war anyone with Regular Army experience must be expected to do administrative tasks, but surely this could largely be avoided in peace time if certain changes were made. One such change could be the adoption of a different conception of the method of filling appointments. In short, our present system dictates that an officer must hold a certain rank to hold a certain administrative (or some other) appointment. Tradition dictates that the A.D.M.S. of a Division or Armoured Division must be a Colonel. It might solve many problems at little inconvenience to others if he could be a Lieutenant-Colonel, Colonel or Brigadier, depending on who was available. This might be extended up and down the chain of command in the field and in all static headquarters and units. By this means, as the choice of administrative officers for a certain appointment would be wider, the call on specialists for such appointments should be reduced. It might be argued that this would cause inconvenience to other arms and services ; this might be so, but R.A.M.C. officers have to be treated differently in any case on account of their status under the Geneva Convention, so other small differences are of no account.

Another suggestion is that a representative committee should be appointed to review all specialties with a view to determining whether their current status and size are appropriate to present-day requirements. It is felt that all specialties should now be of equal status and offer equal opportunity for advancement as far as possible ; also it may be that certain specialties are overloaded and that too much emphasis is being laid on them, to the detriment of others. Denial of equal opportunity, within normal military limits, can only lead to discontent and many retirements.

6. *Temporary Promotion.*—The present wholesale distribution of temporary rank has largely jeopardized the time-proven system of advancement by time and selection as in pre-war days. If this is allowed to continue many officers will spend the majority of their careers in one or more ranks above their substantive ranks. Under the current system, an officer may be faced with the unpleasant fact that his juniors, because they have backed the right horse, and as a result have acquired temporary rank, may be financially, socially and domestically better off, not because he himself is less able, but because he has taken up an essential but less remunerative type of work in the Corps. Also as temporary rank may, under certain circumstances, count towards retired pay in that rank, it may confer not only temporary but also permanent advantages. Furthermore, the frequency of its distribution could well be used by the Treasury as a reason for not raising Corps pay rates. It is considered that much temporary rank could be dispensed with in the Corps and that this step would lead to a much more stable organization. The surrender of temporary

promotion could be used as a powerful bargaining weapon for attaining substantial pay increases.

7. *Dependants.*—The variety of clinical material seen in our hospitals in the United Kingdom generally bears a poor comparison in experience value with that found in civil hospitals, owing to the fact that the vast majority of patients are of a narrow age group and of the male sex. The result is that specialists in our hospitals are naturally limited in their scope, with few exceptions. This, however, could be put right by the Government's effecting a change in legislation to permit service dependants of any age or relationship and also retired personnel and their dependants to receive both in- and out-patient treatment as available from military resources, as is done in the U.S.A. It is interesting to note that at the Walter Reed Hospital, Washington, in 1951, four-fifths of all out-patient attendances were by civilians, *i.e.*, mostly dependants, and of all patients admitted for treatment, almost exactly half were infants, other dependants or those in retired status. The U.S. military hospitals are now in a position to offer to their doctors quite as good experience in any branch of medicine as can be obtained outside, and this, together with their extensive training programmes for interns and residents, is helping to solve the recruitment problem.

8. *Employment of Civilians.*—In pre-war days R.A.M.C. tradesmen were usually men of relatively long engagement and in consequence acquired much experience in their work. Today the vast majority are N.S., and in the short time available cannot be expected to attain the same standards of learning or technique. Standards have fallen considerably in many ways since the war, and although certain medical standards are unlikely to be raised or even maintained without many additional Regular officers, it is felt that many technical and non-medical standards could be rapidly raised to a safe and economic level by the replacement by civilians of the majority of clerks, mess staff, cooks, cleaners, X-ray and other technicians, in all static units. This would, in addition, ensure continuity. The cost of such a scheme would probably be little or no more than at present when one considers that a private soldier costs about £300 per year all found. A further advantage would be that general duty orderlies attached for training in the various departments would have the benefit of receiving tuition from better qualified teachers.

9. *Equipment.*—If the highest standards are to be aimed at and attained, this can only be done by the provision of such medical equipment as is considered necessary by the specialists who use it, within reasonable limits. Such equipment must include such items as the dictaphone into which reports can be dictated for later typing off by stenographers, thus saving time and quill-driving. The hackneyed use of the word "economy" is no longer applicable, however severe this or the next series of crises may be, considering the vast expenditure which has been made on the National Health programme (including the Danckwerts Award) over the past few years. That section of the community

serving in the Army deserves the same standard of treatment as, or better than, obtainable outside, and to give it we require all the modern tools.

*Conclusion.*—It is considered that a commission should be appointed by the Government on the lines of the Warren Fisher Commission, but with wider terms of reference, for the purpose of eliciting the reasons for the decline in recruitment and frequent premature retirement of R.A.M.C. officers, and with a view to making specific recommendations to deal with these problems. Such a commission might also deal with the thorny problems of integration with the N.H.S. and even with the other Armed Services ; judging by the large number of articles on the subject of recruitment which have been published, there should be no shortage of evidence.

[This article was written in 1952, before there was any indication of the appointment of the Waverley Committee.—ED.]

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## **Editorial**

### **REMEMBER !**

ONE hundred years ago, in May, 1854, Britain reluctantly declared war upon Russia. The war in the East was the first for nearly forty years which had touched the life of the British people, and in that time not only had the Army suffered from the parsimony inseparable from peace, but “old men forget.” The young men of the Peninsular and Waterloo were the old men of the Crimea. They had forgotten the lessons of youth, and the commonplaces of 1815 were the brilliant discoveries of 1854.

In no department of the Army was this more true than in the Medical Department. Here the practical applications of these discoveries have been so firmly built into our structure that it is difficult to believe that they were ever sternly and bitterly resented and resisted reforms. But the child of however learned a father must still begin at ABC, and we children, too, have our ABC : Administration, or the military aspects of our profession ; Bodies, or perhaps more accurately, minds—call it morale, man-management, or what you will ; and Clinical Medicine. No administrative advance or ability can be more important than the men in whose minds it germinates, or who are affected by it, the latter the larger and more important group.

On the clinical side, consider two quotations from the introduction to *A Field Surgery Pocket Book* (Revised, 1950) : “The evolution of weapons of destruction has proceeded apace, and worse may be yet to come, but the same surgical problem has been repeated in every war and is likely to be the same in the next. . . .” “The policy of early adequate surgery was *the* lesson of the South African War [it was of the Peninsular], and some of the teachings of the old masters of 1917 were being rediscovered a quarter of a century later. It is the duty of those who go, to record the lessons learned, and of those who come to study them.” It is as surgeons in the Crimean sense of military medical

officers, whatever our professional speciality, that we should remember these lessons.

The demands of the Crimean campaign revealed a shortage of medical officers, which was compensated by the appointment of Acting Assistant Surgeons, many of whom, finding service life congenial, were later granted permanent commissions. The result was a record entry in 1854 of 243 regular medical officers, a rich and remarkable entry. H. T. Sylvester, William Bradshaw and T. E. Hale won Victoria Crosses. Leonard Kidd was twice mentioned in General Orders for gallantry in shipwrecks. Francis de Chaumont, for twenty-two years successively Assistant Professor and Professor of Military Hygiene at Netley, and Sir William Flower, afterwards Hunterian Professor at the Royal College of Surgeons and later still Director of the Natural History Department of the British Museum, became Fellows of the Royal Society; Sir Patrick Heron Watson became F.R.S., Edinburgh. There were yet others of as great distinction but less reward—William Marshall Webb, commemorated by the Marshall Webb Prize; Jeffery Allen Marston, whose account of Mediterranean Fever in the A.M.D. Report for 1863 first separated this condition as a clinical entity from other febrile disorders; Richard Wolseley, younger brother of the Commander-in-Chief-to-be; and the able, genial and eccentric F. T. Buckland, whose *Curiosities of Natural History* on my grandfather's shelves enlivened my childhood and whose kinsman is still serving in the Corps. Another of the 1854 entry was H. C. Miles, whose plan for a Royal Medical Staff Corps, put forward when he had only eleven years' service, had no doubt been forgotten when the R.A.M.C. Warrant was drawn thirty-three years later.

Let us remember, too, that this war-time batch included seven officers of Canadian and two of South African birth. As always, war lined with steel the velvet of the Crown.

But of this record entry, 20 resigned with less than two years' service, 17 under five years, and a further 17 under ten. By 1866, the rank and pay of medical officers were being investigated by a Parliamentary committee; in 1878, another committee was to "inquire into the causes which tend to prevent sufficient eligible candidates from coming forward for the Army Medical Department." What causes did the committee find? That pay did not keep pace with comparable civilian incomes, loss of allowances, shortage of quarters, uncertain tenure of appointments, slowness of promotion; 1878 or 1954? If history does not repeat itself, the lessons of history must be taught to each succeeding generation, and school fees are going up. The last word of King Charles I before he was done to death was—"Remember!"

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**PROFESSOR E. P. CATHCART,  
C.B.E., M.D., D.Sc., LL.D., F.R.S.**

As I lie in the heather basking in the March sun my thoughts are on a man who, twenty years or more ago, was probably doing the same thing on the



western shores of the Isle of Arran while on holiday with his family, the rugged mountains behind him and in front the blue sea stretching far beyond the horizon to Tir nan og, the land of the young.

The man was Professor Cathcart, at that time Regius Professor of Physiology in the University of Glasgow, whose sad death was announced on the 18th of February of this year.

He was like those mountains, massive and strong both in physique and character, and, like the sea, his name and fame had spread to the distant continent and to wherever men of science laboured to solve the secrets of physical and physiological life.

It is his long association with the Army and our Corps, no less than thirty years, which I should like to recall.

In the 1914-18 war, in which he served as an officer in the Corps, when the U-boats were making the food situation very difficult, he was recalled from active service and given the task of determining the food requirements of the soldier. His findings were published by the Stationery Office in a report, "The Energy Expenditure of the Infantry Recruit in Training," which became the basis for the compilation of the various rations issued during and after the war.

Later, with the assistance of two Hygiene officers, experiments to determine the economic load of the soldier were conducted by him as well as many other studies of a similar nature.

He was a regular attending member of the Director of Hygiene's Advisory Committee, where he was the outstanding personality from its inception in 1919 to his resignation in 1944. His knowledge of the Army, his practical common sense, backed by his great learning and experience, were of inestimable value in reaching decisions and in getting recommendations carried through. So highly was his opinion regarded by the War Office and the Treasury that the acceptance of any recommendation bearing his name was to all intents and purposes automatic.

At these and other committee meetings, how simply he expressed his views ! No highfalutin jargon but plain understandable words which we all could follow, and yet so full of knowledge and learning.

During the inter-war period many of us embryo hygienists were trained by him in appropriate and relevant physiological methods. On all who enjoyed this privilege he left his mark.

He was the "grand man" to everyone who knew him, too big to make one feel small ; so full to the brim with kindly and fatherly encouragement, so blatantly frank and honest, so highly charged with enthusiasm, almost boyish in its charm and character, the good Scots tongue and that delightfully infectious laugh. What a man to have known ! I know I speak for the generation of officers that enjoyed his friendship when I say we all loved him very much.

We send our deepest sympathies to his wife and daughters.

DAVID RICHARDSON.

## *Correspondence*

*From* SIR JAMESON ADAMS, K.C.V.O.

HON. APPEALS SECRETARY, KING EDWARD VII'S HOSPITAL FOR OFFICERS  
(*Sister Agnes, Founder*)

DEAR SIR

Will you allow me, through your Journal, to make known the additional facilities now available in King Edward VII's Hospital for Officers, Beaumont House, Beaumont Street, W.1.

The Extension to the Hospital has been completed, the original building has been brought up to date, and the Hospital is now provided with the very latest equipment.

As is already known, the Hospital has a Consulting Staff of eminent physicians and surgeons, and patients who desire to avail themselves of their services are charged in accordance with their means, on a scale agreed by the Council. Patients may, however, still make their own arrangements with any physician or surgeon of their choice if they so desire.

A number of ward beds are set aside for serving officers, who are entitled to free bed, nursing and maintenance. Extra charges are cut down to a minimum and are constantly reviewed and the ability of the patient to pay is always considered. We have recently introduced a Samaritan Fund to assist those in financial need.

The Hospital is mainly for surgical and medical cases, and has its own Medical Officer (from whom preliminary advice can be obtained without charge), a Physiotherapist and an X-ray apparatus.

The Hospital has been disclaimed by the Minister of Health, and is therefore entirely dependent on voluntary support. Subscribers, who are entitled to special rates, are asked to pay £1 yearly by Bankers' Order, which can be obtained from the Honorary Appeal Secretary, 15 Ormond Yard, Duke of York Street, S.W.1, who will also be pleased to receive donations.

All officers, serving and retired, permanent and temporary, are eligible for admission.

Yours very truly,

J. B. ADAMS.

## *Matters of Interest*

### PAPERS BY R.A.M.C. OFFICERS

- Captain B. H. Bass, Major R. G. MacFarlane and Lieut. T. Phillips : Bilateral Hæmorrhagic Effusion Complicating Acute Pulmonary Moniliasis. *Lancet* (1954), i, 709-710.
- Colonel L. R. S. MacFarlane, Major C. K. Anderson and Mr. F. C. Pinion : Stability of the Antigen used in the Price Precipitation Reaction under Differing Temperature Conditions. *Brit. J. Vener. Dis.* (1953), 29, 236-237.
- Lieut.-Colonel J. Mackay-Dick : Bronchography with Dionosil (letter). *Lancet* (1954), i, 163.
- Major D. E. Marmion : Blood Dyscrasias Associated with Chloramphenicol (letter). *Lancet* (1954), i, 520.
- Captain C. M. B. Pare and Captain M. Sandler : Amino-aciduria in March Hæmoglobinuria. *Lancet* (1954), i, 702-704.
- Captain M. Sandler and Captain C. M. B. Pare : Starvation Amino-aciduria. *Lancet* (1954), i, 494-495.

### TRENCH GASCOIGNE PRIZE ESSAY COMPETITION

- Prize :           Thirty guineas and Gold Medal.
- Closing date : 15th November, 1954.
- Subject :        “To what extent will the introduction of atomic weapons and guided missiles modify the traditional functions of the Navy, Army and Air Force ; and what changes in the structure and training of the three Services will be necessary to enable them to perform their new functions ?” or  
                     “Rearmament and the maintenance of large land, sea, and air forces during a cold war cause national bankruptcy. Our economic position at present prohibits the support of large armed forces and, consequently, dominates our strategic policy. Discuss what strategy, in your view, should be adopted in the circumstances and what type of force, bearing in mind the need for efficiency and balance, should be maintained to implement it.”

*General conditions for the essays are contained in A.C.I. No. 102/1954.*

## THE MILOCARIAN ATHLETIC CLUB

Lieut.-Colonel A. E. C. Bredin, *D.S.O., M.C.*, The Dorset Regiment, writes :

I am contributing this short article as a member of the Committee of the Milocarian Athletic Club, and with the approval of Lieut.-General Sir A. Dudley Ward, who is a Vice-President (the present D.C.I.G.S. was an athlete of distinction) and Captain J. R. Gower, *R.N.*, the Chairman of the Committee. The reason for "bursting into print" in this way is because as a Club, the only joint Service Club concerned with sports or games, we feel that, these days, there is too little known about us ; and, as a result, too little interest taken throughout the three Services. Pre-war, the Milocarian Athletic Club was one of the leading clubs in the country ; and up to and including 1948 we always had one or more representatives in the Olympic Games. It is realized that the post-war years, with all their "cold, lukewarm and hot" wars, have involved the Services, and more particularly the Army, heavily in all parts of the world ; and that, as a result, in contrast to the settled existence led by civilian clubs in the United Kingdom, there is no hope of producing teams at home in any way fully representative of the Milocarrians. But that does not mean to say that the three Services should not be made fully aware of the position, and it is considered that more encouragement should, and could, be given to aspiring young athletes in the Royal Navy, Army and Royal Air Force.

Perhaps at this junction it might be as well to remind ourselves of the object of the Club :

- (a) To encourage and raise the standard of athletics and cross-country amongst the officers of the Royal Navy, Army, and Royal Air Force.
- (b) To bring the three Services into closer touch with each other and to form a medium through which better liaison of the Services may be obtained.
- (c) To enter teams for the A.A.A. Relay Championships, open meetings and inter-club matches, thereby providing the opportunity for members of the three Services to compete together.

No one can gainsay that the object, as given above, is a very worthy one, and one, moreover, deserving of proper support. In the past, too much has depended on the enthusiasm of certain members ; and I can speak with experience as it fell to my lot to start and maintain the Middle East branch of the Club during 1950-1. The President of the Club is Lieut.-General Sir Frederick Browning, and last year *H.R.H. The Duke of Edinburgh* was very pleased to extend his patronage to the Club.

Now a word about the history of the Club. Largely the conception of Major the Hon. W. S. P. Alexander of the Irish Guards (a brother of the Field-Marshal) and at that time officer in charge of Athletics at Sandhurst, and Captain I. E. F. Campbell, *D.C.L.I.*, also on the staff at Sandhurst, the Club was formed in 1930. This took place after the triangular contest between Woolwich, Sandhurst and Cranwell, with the sanction of the three commandants at that time (Major-

Generals H. D. de Pree and E. S. Girdwood and Air Vice-Marshal A. M. Longmore). Originally the membership was open to Blues and Half Blues from the three Service Cadet Colleges ; but it is now open to all officers of the three Services, and cadets, with certain provisos as to the standard to be obtained to qualify for election. The name of the Club was derived from a combination of Milo and Icarus. Milo was a strong man of Croton in Southern Italy in the sixth century B.C., famous for winning the Pentathlon (wrestling, running, long jumping, throwing the discus and javelin), and so the ancient Olympic Games, on no fewer than six occasions. Icarus, and his father Dædalus, fled from Crete with wings attached to their bodies by wax to escape the wrath of Minos ; Icarus ignored the parental warning not to fly too near the sun and when the wax melted and his wings dropped off he fell into what is now known as the Icarian Sea. The Club colours are dark blue for the Royal Navy, red for Sandhurst, yellow for Woolwich and light blue for Cranwell.

Between 1931 and 1939 the Club won many successes on the track, notably in the A.A.A. Championships, the Kinnaird Trophy and the *News of the World* Whit-Monday Games, besides having representatives in the Olympic Games of 1932 and 1936. During the Second World War over a hundred Milocarians were killed in action. In 1946, the Milocarian Trophy was purchased and presented by the Club to the Amateur Athletic Association for competition among schools as a memorial to those members of the Club who fell in the war. As a matter of interest, the trophy was won in 1952 by King Alfred's School, Plön, B.A.O.R., and Lancing College were second ; Halton Apprentices' School, where D. O. Finlay started his career in the R.A.F., also entered. It is suggested that all members of the Club should encourage their old schools to take part in this good and interesting competition. After the war, it was not until 1948 that the Club found itself in a position to embark on a full track season programme ; and owing to lack of recruiting during the war years the number of active athletes was limited. However, no less than five Milocarians represented Great Britain in the Olympic Games that year. In the winter of 1948-9, the Club gained 5th place in the Southern Junior Cross-Country and 4th place in the National Junior Cross-Country Championships—in which members of the Club under 21 competed as "Juniors." All things considered, the results in 1950 and 1951 were good even by pre-war standards ; and the membership increased by anything between sixty and one hundred during the years 1948-1951. There are now overseas secretaries in Germany, the Middle East (Egypt), the Far East (three) and in Austria, and some of the local branches abroad are really active.

Among the more famous athletes who have worn the Milocarian colours are A. W. Sweeney, W. H. Summers, G. L. Rampling, R. A. Morris, E. W. Denison, C. H. Stoneley, D. O. Finlay, Lord Burghley, A. J. A. Watson, L. Reavell-Carter, C. J. Reidy and M. V. W. Chote. J. V. Powell had made his best times for the 880 yards (1 min. 53.3 sec. at Chelmsford in 1936) and 800 metres (1 min. 50.8 sec. at Stockholm in 1936) before becoming a member of the Club.

In conclusion, I should like to say the following :

(a) An extract from the Secretary's report for 1952 reads as follows : "The Club did not enter for any open competitions. . . . It seems unlikely that the Club will regain its former position as one of the leading clubs in the country until the cold war has subsided. At present the majority of young officers, particularly in the Army, go overseas within a few months of leaving cadet colleges." It is all the more important, therefore, that when active members do return home from abroad they should at once get in touch with the Secretary and the match manager. The latter has had great difficulty in raising teams during the last season or so.

(b) It would help active members enormously if commanding officers could give more encouragement to a good cause and perhaps a few facilities to keen young officers. I know commanding officers' difficulties well enough—having been a commanding officer myself and being just about to become one again !

(c) There is no doubt that amateur athletics generally would benefit greatly from a more active Services representation such as that provided by teams of the Club. Moreover, foreign competition has grown more severe in recent years.

(d) The cause of joint-Service co-operation is helped greatly, on the lowest officer levels, by members of the three Services competing together—one of the objects of the Club. And today our stock-in-trade—training for war and fighting the Queen's enemies when necessary—is more than ever a joint-Service affair.

(e) Of the three Services, the Army is probably in a better position, under normal conditions, to support the Club than the Royal Navy and Royal Air Force—by virtue of our greater numbers and the fact that we are the "land animal"—though we are probably the hardest hit while the present unsettled state of affairs prevails.

(f) Further details regarding the Club, including eligibility for membership, can be obtained from the Honorary Secretary, Captain D. J. McNabb, R.A.O.C., Command Ammunition Depot, Bramley, Hants.

## *Book Reviews*

**FRENCH'S INDEX OF DIFFERENTIAL DIAGNOSIS.** Edited by Arthur H. Douthwaite, M.D., F.R.C.P. 7th Edition. Bristol: John Wright & Sons, Ltd. 1954. Pp. xii+1,046. 731 illustrations, including 200 in colour. £5 5s.

After an interval of eight years, the appearance of a new edition of this comprehensive reference work is welcome. The text has been revised and most of it rewritten by a team of eminent contributors. The illustrations, especially those of radiographs, are ample and of a high standard. This book can be confidently recommended to all physicians in military and civil practice.

W. R. M. D.

**CLINICAL ENDOCRINOLOGY.** By Allan William Spence, M.A., M.D.(Cantab.), F.R.C.P.(Lond.), Physician, St. Bartholomew's Hospital, London. Pp. xiii + 696. 59 illustrations, 2 colour plates. London: Cassell & Co. Ltd. 1953. 50s.

This is an outstanding book dealing with all aspects of clinical endocrinology. A short historical note and a description of the actions of the various hormones preface the detailed consideration of each gland and disorders of its function. The chapters on Cushing's syndrome, hypopituitarism, and Addison's disease exemplify the general high standard throughout the book.

The whole subject is presented clearly and in a most readable form with ample illustrations. A separate section is devoted to miscellaneous disorders of probable endocrine origin. A useful appendix contains details of the preparations and methods of administration of the steroid hormones. The bibliography is complete and adds greatly to its value as a reference work. Though written primarily for general physicians, this excellent book should be on the shelves of all surgeons, obstetricians and gynaecologists.

W. R. M. D.

**SECOND ANNUAL REPORT ON STRESS.** By Hans Selye, M.D., Ph.D., F.R.S. (Canada) and Alexander Horava, M.D. Pp. viii+526. Montreal: Acta, Ltd.

The Second Annual Report on Stress attempts to interpret various medical publications during 1952 in terms of Stress and the General Adaptation Syndrome. The correlation with Professor Selye's concepts of over 4,000 articles, covering an extremely wide and specialized field, demands a knowledge of basic theories. Those still unconvinced or unaware of the influence of Stress in health and disease are introduced to the subject, while further chapters deal with criticisms, problems and other pertinent matters, including an atlas of photographs and some views on the modified theory of medicine (based on Stress and Adaptation).

This is a book of reference, and as such can only be recommended to those genuinely interested in endocrinology, more particularly those able to draw their own conclusions from the material. The technique of presentation is ingenious and effective, while the more general chapters may benefit all who are neither confused nor discouraged by the complex terminology of this school of thought.

W. H. J. S.

**EMERGENCY SURGERY, PART V.** By Hamilton Bailey, F.R.C.S.(Eng.), F.A.C.S., F.I.C.S., F.R.S.E., assisted by Norman M. Matheson, M.B., Ch.B., M.R.C.P.(Lond.), F.R.C.S.(Eng.), F.A.C.S. Pp. 180. 241 illustrations. Bristol: John Wright; London: Simpkin, Marshall. Sixth Edition. 1953. 21s.

This is the last part of the sixth edition of this very well known book. It consists of 928 pages full of useful information, clearly expressed and printed, and beautifully illustrated.

The major part of the volume deals with what are usually referred to as "the special departments," *i.e.*, eyes, ears, nose and throat.

The paragraph on "Snake Bites" on page 801 is open to criticism. It would be more appropriate for a book on "First Aid," being too brief and making no mention of antisera or the treatment of either circulatory or respiratory complications. To give references for further study is good, but not sufficient.

The section on surgical emergencies in the tropics will be of special interest to Service Medical Officers, and all who practice surgery abroad. The volume has another asset for those who travel; it is bound in a soft cover, which greatly reduces bulk and weight.

The appendix at the end is full of odds and ends of interest and practical value and should not be overlooked.

This is a volume that every surgeon should have in his library.

The authors and publishers, Messrs. John Wright & Sons Ltd., are to be congratulated on their excellent production.

R. S. H.

**A GUIDE TO HUMAN PARASITOLOGY.** By D. B. Blacklock, C.M.G., M.D.(Edin.), D.P.H.(Lond.), D.T.M.(Liv.) and T. Southwell, D.Sc., Ph.D., A.R.C.Sc., F.Z.S., F.R.S.E. Revised by T. H. Davey, O.B.E., M.D.(Belfast), D.T.M. (Liv.). Fifth Edition. Pp. viii+228. 3 coloured plates and 120 illustrations. London: H. K. Lewis. 1953. 25s.

This is an excellent book for Medical Officers going overseas and, indeed, for those staying at home. It is invaluable for the Senior and Junior Officers' Courses at the R.A.M. College. It contains several additions to previous editions and is, according to the preface, intended for those taking the Diplomas of Tropical Medicine and Public Health.

Although it contains references to many of the rarer parasites, such as



Coenurus and Heterophyes, it is doubtful if it is quite full enough for the examination mentioned. For example, there is but a fleeting reference to Coccidia and no mention at all of Toxoplasma—although it is admitted the latter is as yet unclassified, but is, however, undoubtedly a parasite. It is noted with gratification that the authors subscribe to the view that *Iodamoeba butschlii*, *Endolimax nana*, and *Dientamoeba fragilis* are non-pathogenic. Perhaps wisely they skate over the pathogenicity of *Giardia lamblia*—but those of us who have served in India, I think, are left with no doubts on this score.

The book has many plates and some very interesting and helpful diagrams. It is, above all, easy to read and assimilate.

L. R. S. M.

**SURGERY OF REPAIR AS APPLIED TO HAND INJURIES.** By B. K. Rank, M.S.(Melb.), F.R.C.S.(Eng.), F.R.A.C.S., and A. R. Wakefield, M.S.(Melb.), F.R.C.S.(Eng.), F.R.A.C.S. Foreword by Sir Gordon Gordon-Taylor. Pp. xiv + 256, 188 illustrations. Edinburgh: Livingstone. 1953. 40s.

This authoritative work by two distinguished Australian surgeons will give valuable assistance and guidance to all those who may be called upon to treat injuries of the hand. The book is sound from cover to cover. It is beautifully and lucidly written with numerous excellent illustrations. Such a practical book could only have been written by those who have had vast clinical experience, built upon close daily contact with patients.

Every surgeon in the Army would be well advised to add this useful surgical companion to his textbooks.

R. A. S.

**CATALOGUE OF FILMS ON PSYCHIATRY.** London: Scientific Film Association. 1953. 7s. 6d. (By post, 8s. 1d.)

A critical catalogue of 107 films on psychiatry, which are available in this country, divided into seven sections: Developmental Psychology, Educational Psychology, Testing Techniques, Industrial and Applied Psychology, Animal and Experimental Psychology, Abnormal Psychology and Psychiatry, and Juvenile Delinquency. Of 72 films which have been graded as "recommended," "suitable," or "unsuitable" for each of five types of audience, only 43 are "recommended" for showing to any of them. As the catalogue is issued in loose-leaf form to accommodate new material to be published from time to time, it seems a pity that a paper cover should have been chosen.

J. B. N.

**MUSCLE RELAXATION AS AN AID TO PSYCHOTHERAPY.** By Gerald Garmany, B.Sc., M.B., Ch.B., M.R.C.P., D.P.M. Pp. 65. London: The Actinic Press. 3s. 6d.

This book presents in compact form the technique of relaxing tense muscles as an aid to the production of a relaxed mind. It is clearly written and fulfils its purpose to provide the psychiatrist and the physiotherapist with a clear

appreciation of the principles underlying the technique of muscle relaxation. Technical words are reduced to a minimum and are explained in a convenient glossary. The material provided in the book should help the physiotherapist to co-operate fully with the psychiatrist in cases selected by the latter for this form of treatment.

The book can be recommended to all Army psychiatrists, and to physiotherapists who are asked to carry out relaxation therapy.

R. R.

PHARMACEUTICAL EMULSIONS AND EMULSIFYING AGENTS. By Laurence M. Spalton. Pp. vii+138. London: The Chemist and Druggist, 1953. 7s. 6d.

The second edition of this book has two changes from the first edition, a stiff cloth cover and an index. The subject-matter has, of course, been brought up to date by the author.

The first two chapters deal with the theory of emulsions and emulsifying agents. These are followed by two chapters on the formulation and preparation, with practical details, of emulsions. The last two chapters describe preserving agents and how they should be used. Finally, there is a comprehensive table of emulsifying agents, with their trade and chemical names, their uses and name of the manufacturer in this and other countries.

The book is written in plain, straightforward language easily intelligible and is essentially practical. It should be very useful to pharmacists, chemists and other persons who manufacture or store emulsions of all descriptions.

The publishers are to be congratulated on the clarity of the type, lack of printing errors and the general appearance of the book.

S. E.

THE BRITISH JOURNAL OF TUBERCULOSIS AND DISEASES OF THE CHEST. London: Baillière, Tindall and Cox.

The oldest organ dealing with tuberculosis and chest diseases entered its forty-eighth year in January, 1954, in a new cover, increased in size, and with its Editorial Board enlarged from eight to twelve members by the inclusion of four distinguished representatives of English provincial medicine. With such excellent and important material so handsomely produced, it is unfortunate that the journal should be saddled with the occasional contributor who will not check his references.

J. B. N.

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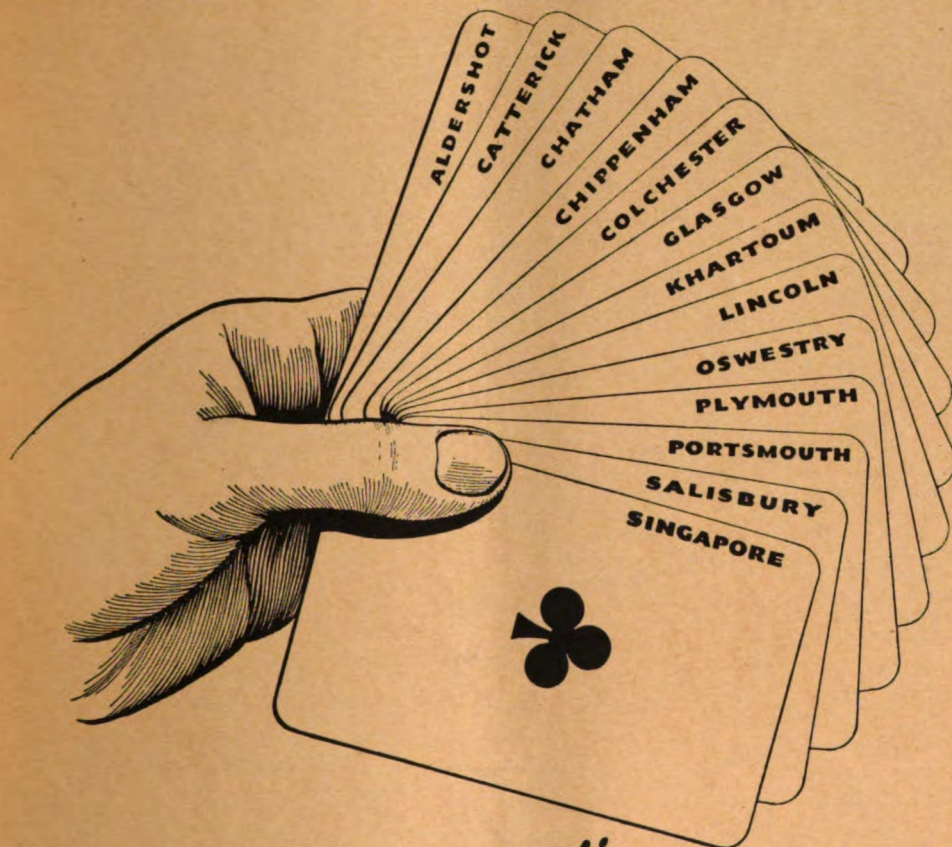
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# Journal

## OF THE Royal Army Medical Corps



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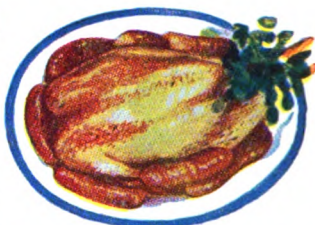


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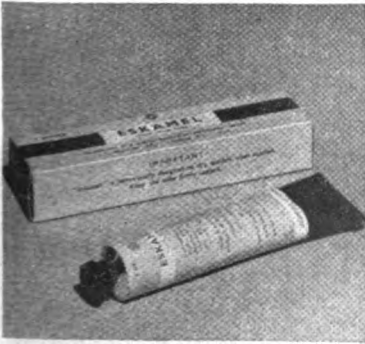


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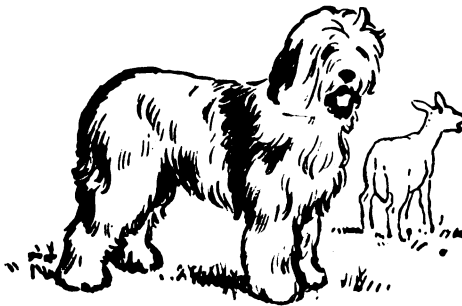
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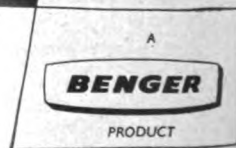
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# Journal of the Royal Army Medical Corps

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## *Original Communications*

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### THE PHYSIQUE OF CHELSEA PENSIONERS

BY

Lieut.-Colonel F. M. LIPSCOMB, O.B.E., F.R.C.P.

and

R. W. PARNELL, D.M., M.R.C.P.\*

MEN admitted to in-pension at the Royal Hospital, Chelsea, are men in receipt of an army or service disability pension, men of good character both in their army career and subsequent civilian life, usually men with many years' army service, often experience of both world wars and sometimes too of the Boer War as well. It was thought, therefore, that the physique of pensioners surviving such strong selective influence might make an interesting study, both intrinsically and because of the bearing this might have on physical standards of recruiting. One of us (F.M.L.) therefore took certain physical anthropometric measurements on a series of 50 men admitted to in-pension from June, 1952, to April, 1953. A small number (11) admitted during the same period were either too old or too infirm to be measured, but not enough to prevent the sample being fairly representative.

The age of subjects ranged from 56 to 84, but only 16 were under 70, and the average age was 73 years. One peculiar advantage in studying pensioners was that their height and weight had been recorded when they joined the colours, usually between the age of 18 and 24, though six had joined earlier and one as early as 13 years. In a few, subsequent heights and weights were also available. These early records made it possible to assess age changes in the measurements, and also to compare their physique at approximately 20 years

---

\* Nuffield Research Physician in the Constitutional Aspects of Psychiatric Medicine, The Warneford Hospital, Oxford. Lately Student Health Physician at the Institute of Social Medicine, Oxford.

of age with that of another selected group of the population, namely, undergraduates, who were of similar age though not measured till between 1948 and 1951 by R.W.P.

#### MEASUREMENTS OF PENSIONERS AND UNDERGRADUATES COMPARED

The measurements of pensioners and of undergraduates are compared in Table I. When they joined the colours, 44 pensioners, ranging in age from 18 to 26 with an average of 20.5 years, were nearly 4 inches shorter than the undergraduates. They were also 25 lb. lighter in weight, and even after gaining weight in the intervening years were at the average age of 73 still 5 lb. lighter than the undergraduates. The evidence so far might be explained simply enough as a consequence of size alone, but the next points veto any such possibility. The ponderal index (mean height in inches  $\div \sqrt[3]{\text{mean weight in lbs.}}$ ) was 13.2 for both

TABLE I.—THE MEASUREMENTS OF PENSIONERS COMPARED WITH THOSE OF UNDERGRADUATES

Measurements	Chelsea Pensioners			Undergraduates		
	No.	Mean $\pm$ S.E.	S.D.	No.	Mean $\pm$ S.E.	S.D.
Height (ins.) (present)	50	66.06 $\pm$ 0.37	2.64	498	69.99 $\pm$ 0.11	2.48
Height on entry (18 years +)	44	66.27 $\pm$ 0.28	1.98	—	—	—
Weight (lbs.) (present)	50	145.34 $\pm$ 3.60	25.47	498	151.43 $\pm$ 0.80	17.94
Weight on entry (18 years +)	43	129.05 $\pm$ 1.69	11.04	—	—	—
Humerus, bicondylar width (cms.)	50	7.02 $\pm$ 0.06	0.44	361	6.79 $\pm$ 0.02	0.35
Femur, bicondylar width (cms.)	50	9.47 $\pm$ 0.06	0.42	361	9.70 $\pm$ 0.02	0.41
Biceps girth (ins.)	50	11.57 $\pm$ 0.17	1.18	151	12.21 $\pm$ 0.07	0.88
Calf girth (ins.)	49	13.26 $\pm$ 0.15	1.07	151	14.30 $\pm$ 0.07	0.80
Subcutaneous fat:						
Subscapular (mms.)	50	11.54 $\pm$ 0.73	5.14	408	14.50 $\pm$ 0.23	4.70
Suprailiac (mms.)	50	8.56 $\pm$ 0.65	4.52	408	11.50 $\pm$ 0.23	4.70
Over triceps (mms.)	50	7.98 $\pm$ 0.44	3.12	408	10.50 $\pm$ 0.18	3.70
Total of three fat measurements	50	28.08 $\pm$ 1.63	11.50	408	35.14 $\pm$ 0.58	11.70

undergraduates and pensioners when young, and yet after some fifty years, during which pensioners lost insignificantly in height but gained on the average 20 lb. in weight, it is found that the sum of their three skinfold measurements of subcutaneous fat is still more than half a standard deviation less than that of undergraduates, and such a difference is of course highly significant.

Unless fat had been deposited at quite different sites in these two groups of men, the only reasonable conclusion would appear to be that pensioners' weight must have been present originally to a far greater extent in the form of bone and muscle. Confirmation of this is found in bone and muscle measurements, for these, in spite of pensioners' much smaller stature, compare closely with those of undergraduates; their humerus bicondylar measurements being slightly larger, their femoral bicondylar measurements slightly smaller.\* Muscle

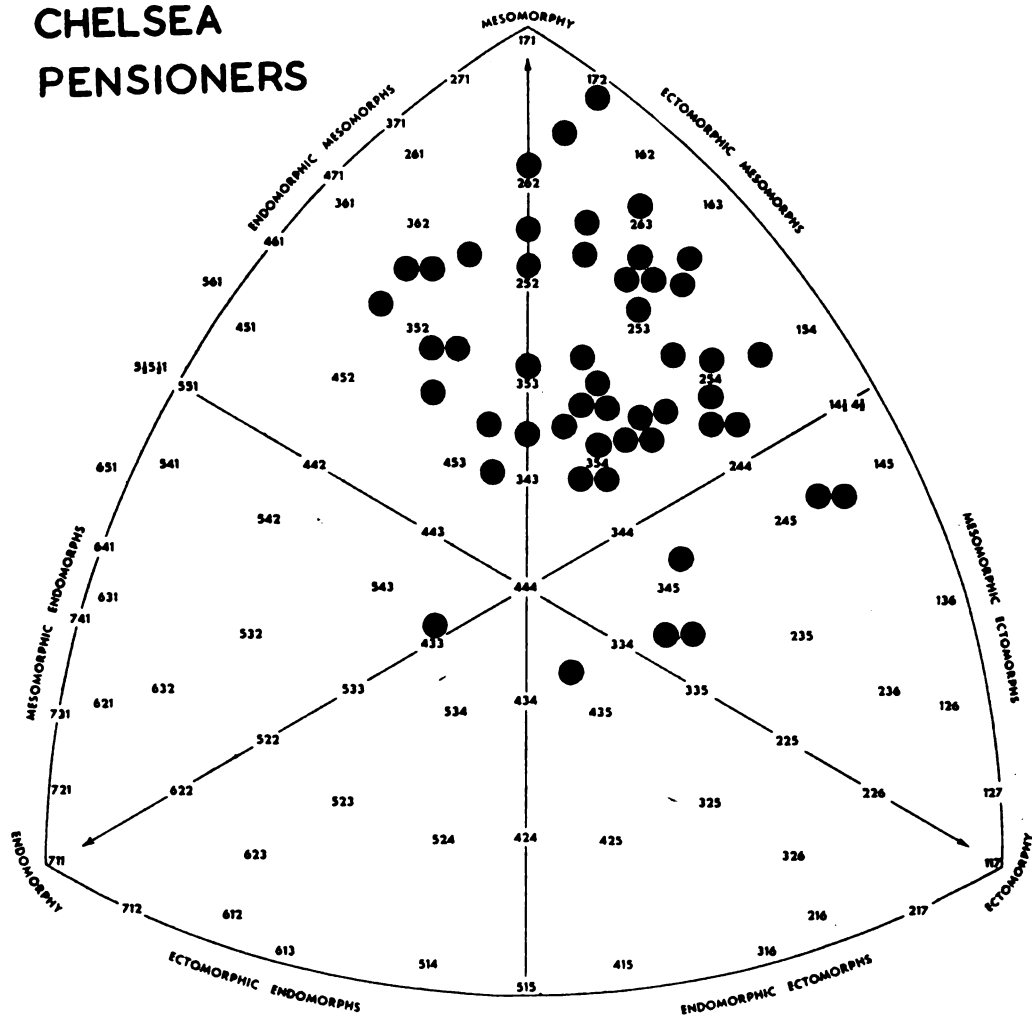
\* Both these slight differences are significant in a statistical sense, but it is less certain that the difference is biologically significant because no check is available on interobserver error in taking these particular measurements, although both observers were at pains to follow the same technique.

Figure 1. The average Chelsea Pendlover. Present measurements (average age 73 years) - ○—○—○  
 Type 2½½. Measurements on entry (average age 20 years) - □- - -□

Standard Scale	-3	-2½	-2	-1½	-1	-½	MEAN	+½	+1	+1½	+2	+2½	+3
Height (ins.)	62.6	63.8	65.0	66.2	67.5	68.8	70	71.2	72.4	73.6	74.9	76.1	77.3
Weight (lbs.)	96	105	114	123	132	141	150	158	167	176	185	193	202
Height weight ratio	11.6	11.8	12.1	12.4	12.6	12.9	13.2	13.5	13.7	14.0	14.3	14.5	14.8
Bone: Humerus (oms.)	5.7	5.9	6.1	6.3	6.4	6.6	6.8	7.0	7.1	7.3	7.5	7.7	7.8
Femur	8.5	8.7	8.9	9.1	9.3	9.5	9.7	9.9	10.1	10.3	10.5	10.7	10.9
Muscle: Biceps (ins.)	9.6	10.0	10.5	10.9	11.3	11.8	12.2	12.7	13.1	13.5	14.0	14.4	14.9
Calf	11.9	12.3	12.7	13.1	13.5	13.9	14.3	14.7	15.1	15.5	15.9	16.3	16.7
Fat: Subcut. scapular (ms.)	5.0	6.0	7.0	8.5	10.5	12.5	15.0	18.0	21.5	26.0	31.0	38.0	+
" suprailiac	3.0	4.0	5.0	6.5	8.5	10.0	12.0	15.0	19.0	23.0	28.0	35.0	+
" over triceps	3.5	4.5	5.0	6.0	7.5	9.0	10.5	12.5	15.0	18.0	21.0	25.0	30.0
Total of 3 subcut. (T.F.)	12	14	17	20	24	29	35	42	50	60	72	87	104

girths, of biceps and calf, were significantly smaller in pensioners, but in relation to their height they too were proportionately larger than in undergraduates.

## CHELSEA PENSIONERS



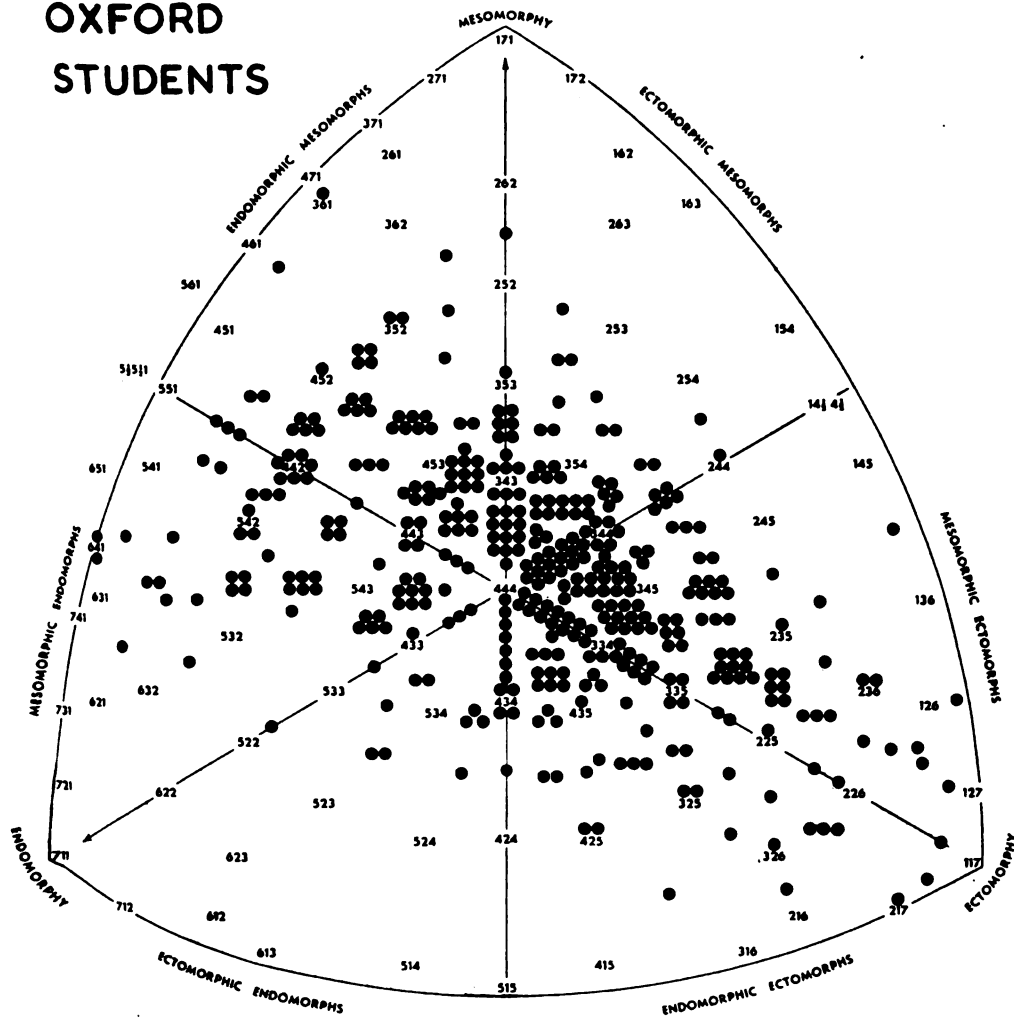
A SCHEMATIC TWO-DIMENSIONAL PROJECTION OF THE THEORETICAL SPATIAL RELATIONSHIPS AMONG THE KNOWN SOMATOTYPES

FIG. 2. THE SOMATOTYPE DISTRIBUTION OF 50 CHELSEA PENSIONERS

These differences in physique may be summarized in profile form, and this is illustrated on what is called the deviation chart of male physique (see Fig. 1) based on the undergraduate measurements. Essentially the deviation chart consists of a series of 13 point standard scales with half standard deviation units anchored to the mean values. From the profile thus plotted it is possible to

estimate Sheldonian somatotype with reasonable accuracy by means of a technique described by one of us (R.W.P.) elsewhere. Having plotted the average measurements of pensioners it is possible to estimate the somatotype of a

## OXFORD STUDENTS



A SCHEMATIC TWO-DIMENSIONAL PROJECTION OF THE THEORETICAL SPATIAL RELATIONSHIPS AMONG THE KNOWN SOMATOTYPES

FIG. 3. GENERAL DISTRIBUTION OF 405 OXFORD UNDERGRADUATES (MEN)

mythical figure, "the average Chelsea pensioner," by using Sheldon's ponderal index somatotype tables.\* The answer is in the region of somatotype  $2\frac{1}{2}53\frac{1}{2}$ . It is further possible to plot the pensioners each on a separate deviation chart

\* Tables for the age group 16-20 were published in *Varieties of Human Physique*; we have also had access to tables for 63-year-old persons by private communication with Dr. Sheldon.

and to estimate their somatotypes individually. This has been done and is illustrated in Fig. 2. It will be seen that the majority were mesomorphs, most of them ectomorphic-mesomorphs, but there were nine endomorphic-mesomorphs and five mesomorphic-ectomorphs. Only two were rated as low as 3 in mesomorphy, and in one of these muscle wasting associated with chronic bronchiectasis may have led to an incorrectly low figure. Compared with the somatotype distribution of undergraduates estimated in the same way (see Fig. 3), many pensioners will be seen to lie beyond the mesomorphic limits found in undergraduates. Medical examination on entering the army no doubt excluded a certain proportion of strongly dominant ectomorphs and endomorphs such as are found among undergraduates, but there is evidence of strong selective influence over and above this factor by itself; for example, the somatotype distribution of American aviation cadets published by Sheldon, Hartl and McDermott reveals a distribution lying between the two groups now under discussion.

It is not intended to dwell here on the differences in temperament likely to be associated with these differences in physique, but most readers will have a fairly clear idea of the differences that they would expect to find in the two groups. If not, reference may be had to Sheldon and Stevens' instructive book describing the correlations they found between body build and temperament in university students.

#### A NOTE ON THE CHANGES ASSOCIATED WITH AGE

It has already been noted that the reduction in height associated with age was insignificant. This is in itself of interest because we are not aware of any similar study with measurements taken on the same individuals after a lapse of so many years. Evidence of diminishing height with increasing age in cross-sectional studies of the population is commonly interpreted as due either to progressive shrinkage of older people or to increase in stature of the younger generation. The present evidence is against shrinkage, but it is admittedly inconclusive because if the pensioners did not gain their full stature till after the age of 21, and this is not only possible but perhaps even probable fifty years ago, they may have grown subsequently and later still lost an almost equal amount.

Another note concerns the amount of subcutaneous fat found in association with various gains in weight (see Table II).

TABLE II.—THE AVERAGE SUM OF SKINFOLD MEASUREMENTS CORRESPONDING TO WEIGHT GAIN

Gain in weight in lbs.	No.	Total skinfold thickness (mms.)
40 +	7	44.3
20-39	13	30.4
0-19	12	24.3
Weight loss 1-12	11	18.4

From this it would appear that where no weight change occurred the average total skin thickness was about 21 mm., and it may be shown graphically that

among pensioners there is a roughly linear relationship in which probable increase in total skin thickness in millimetres for the three measurements equals approximately two-fifths of the gain in pounds weight since the age of 20. The relationship is expressed by the regression equation :

$$\text{Total fat (mms.)} = 0.385 \text{ gain in lbs. weight} + 21.5.$$

This information may be used to estimate the amount of fat deposition associated with age changes in weight : together with the records of height and weight on joining the army it provides a useful check and thereby increases reliability in the somatotype assessments. Because the somatotype distribution of pensioners is sharply localized it would be unsafe to apply this information beyond the limits of present data, but it is of interest and important when estimating somatotype to examine and take note of the average weight gain in pounds according to endomorphy estimates (see Table III).

TABLE III.—AVERAGE WEIGHT GAIN IN LBS. CORRESPONDING TO ESTIMATE OF ENDOMORPHY

Endomorphy	No.	N/S	Gain in lbs. weight
1-1½	7	1	0.7
2	13	1	5.8
2½	7	3	14.6
3	9	1	39.4
3½	5	2	40.4
4	1	—	3.0
	42	8	

From this it appears that an endomorphic rating of one is accompanied by minimal weight gain during life, an estimate of 3½ in endomorphy with roughly 40 lb. gain in weight. No conclusion for endomorphy ratings above this can be drawn from the present material. The trend of results is hardly surprising since endomorphy was defined as "soft roundness throughout the body," and although Sheldon, Stevens and Tucker make little if any specific mention of subcutaneous fat, their definition clearly implies that the propensity to put on subcutaneous fat is a prominent characteristic of endomorphs.

The only other evidence of changes associated with increasing age of pensioners comes from calculation of mean values for individual measurements in successive age groups. These may be summarized shortly by saying that up to 80 years of age there was no evidence of muscle wasting in biceps or calf and no evidence of loss of subcutaneous fat.

#### COMPARATIVE ANALYSIS OF PHYSIQUE BY THE "CLOCK" METHOD

The "clock" method of physical classification has been outlined previously (R.W.P., 1952). It is a three-dimensional distributive classification depending on height, weight and the three skinfold measurements. The ponderal index (height ÷ cube root of weight) is plotted as ordinate and the total of three fat measurements as abscissa both with scales in standard score. New axes were drawn at the point of intersection of mean values obtained from undergraduates, and the four quadrants (A—D) thus obtained were :



- A. Light build ; thinner than average.
- B. Light build ; fatter than average.
- C. Heavy build ; thinner than average.
- D. Heavy build ; fatter than average.

Each quadrant was then divided into a central or mid-range section separated from a peripheral part lying beyond a circle with radius one standard deviation centred on the middle point of the distribution. Radii at 30-degree intervals were then drawn to subdivide each quadrant into three equal sectors which were numbered as on a clock face, so that it is not difficult to remember that asthenic persons with more than average subcutaneous fat appear from 1 to 3, tubby and obese persons from 4 to 6, muscular ones from 7 to 9, and the thin and wiry ones from 10 to 12. In Table IV the percentage distribution of Chelsea pensioners both now and on entry to the service is compared with that of undergraduates. Total fat was estimated for pensioners at the age of 20 from the information obtained about their gain in weight.

TABLE IV.—PERCENTAGE DISTRIBUTION OF "CLOCK" TYPES IN PENSIONERS COMPARED WITH THAT IN UNDERGRADUATES

Sector	1-3	4, 5	6	7-9	10	11, 12	All
	Asthenic (Fat)	Obese	Pyknic	Muscular	Wiry	Asthenic (Thin)	
<i>Peripheral</i>							
Undergraduates	1.6	11.9	4.1	7.4	6.4	16.6	48.0
Pensioners now	0.0	2.0	18.0	56.0	16.0	2.0	94.0
Pensioners on entry	0.0	0.0	0.0	55.8	30.3	2.3	88.4
<i>Mid-range</i>							
Undergraduates	7.2	6.6	5.0	13.3	12.7	7.2	52.0
Pensioners now	0.0	0.0	4.0	2.0	0.0	0.0	6.0
Pensioners on entry	0.0	0.0	2.3	4.6	4.6	0.0	11.5
<i>Mid-range and Peripheral</i>							
Undergraduates	8.8	18.5	9.1	20.7	19.1	23.8	100.0
Pensioners now	0.0	2.0	22.0	58.0	16.0	2.0	100.0
Pensioners on entry	0.0	0.0	2.3	60.4	34.9	2.3	99.9

At the average age of 73 almost all the pensioners (96 per cent.) were found in sectors 6 to 10, and of this group all but the last 6 per cent. were outside the middle range. After allowing for changes in weight and subcutaneous fat brought about by age it is estimated that 95.3 per cent. on entry were found in sectors 7 to 10, that is within rather narrower limits, and of these 86.1 per cent. were placed peripherally, having stocky muscular physiques with little subcutaneous fat. In contrast just under 40 per cent. of undergraduates were found in sectors 7 to 10, and of these only 13.8 per cent. were peripheral, the remainder (25.1 per cent.) being of mid-range build.

#### SUMMARY AND CONCLUSIONS

1. Fifty men were measured on admission to in-pension at the Royal Hospital, Chelsea. Compared with Oxford undergraduates, pensioners, when

they joined the colours, had been nearly 4 inches shorter and 25 lb. lighter in weight. At the average age of 73, pensioners' height had not altered significantly, but they were then only 5 lb. lighter. In spite of this gain in weight they still had less subcutaneous fat than undergraduates. Their bone and muscle girth measurements were larger, however, in relation to their height, and there is little doubt that a larger proportion of their weight was present in this form.

2. Their somatotype distribution reveals them mainly as mesomorphs, with a few mesomorphic-ectomorphs but only occasionally any other body build.

3. The chief age changes in their physique concern increasing weight and subcutaneous fat. The relationship may be expressed by the regression equation :

$$\text{Total of three skinfold measurements in mms.} = 0.385 \text{ gain in lbs. weight} + 21.5.$$

4. With endomorphy ratings under 2 the average gain in weight during some fifty years of adult life was negligible. The average weight gain increased as endomorphy ratings increased. Endomorphy ratings of 3 were associated with roughly 40 lb. gain in weight. Only one man was rated as high as endomorphy 4.

5. The physique of pensioners and of undergraduates was compared, using the "clock" method of classification which is based on height, weight and three subcutaneous measurements. A high proportion of pensioners (95.3 per cent.) were muscular and wiry (sectors 7 to 10), compared with 39.8 per cent. of undergraduates. Pensioners deviated much further from the central point of the distribution and only a few had mid-range physiques.

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# VIRUS JAUNDICE, PARTICULARLY ARSENOTHERAPY JAUNDICE, AMONG THE FORCES IN CYPRUS DURING THE LAST WAR

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## INTRODUCTION

JAUNDICE due to virus infection has long been a special problem in times of war. Large numbers of cases occurred in both world wars with opportunities for the study of epidemiological, clinical and pathological manifestations. As a result there have been considerable advances in knowledge of infective jaundice in the past thirty-five years. Although the concept of catarrhal jaundice was questioned as long ago as 1917 by Martin, it held the field during the inter-war years, being gradually superseded by the conception of hepatitis as the usual cause of infective jaundice (Rolleston and McNee, 1929 ; Cullinan, 1939). It became appreciated that jaundice caused by a simple catarrh of the bile ducts was exceedingly rare. After the introduction of the technique of liver biopsy by Iversen and Roholm (1939), these workers and later Dible, McMichael and Sherlock (1943) elucidated the morbid anatomy of the liver in different forms of infective jaundice.

Soon after the introduction of arsenicals, interest was aroused in the jaundice which often appeared during their use in the treatment of syphilis. In 1919 Lynch and Hoge reported a patient with arsenotherapy jaundice (AsJ) dying with almost complete destruction of the liver parenchyma, and as a result of experiences during the First World War the Medical Research Council organized investigations into the toxic effects of arsenobenzol preparations, the results being published in three Special Reports (Parnell and Fildes, 1919 ; Turnbull, 1920 ; *Special Report No. 66*, 1922). The fact was established that patients receiving these drugs might die with jaundice and severe necrosis of the liver. Ruge (1927 and 1931) studied the epidemiology of AsJ and was the first to make notable contributions in this field.

In 1943 it was suggested at about the same time by both McCallum and Bigger that defective syringe technique might be a common means of spreading AsJ. The very large drop in the number of cases following improved methods of injection has confirmed this (Salaman, 1944 ; Willcox, 1946). There are probably closely related viruses causing the two forms of acute infective jaundice, infective hepatitis (IH) and serum hepatitis (SH). Present opinion is that the virus responsible for AsJ is the same in most patients as that for SH. There are, however, unresolved problems. Although there are distinctions between IH and SH in respect of incubation period, mode of spread and immunity, clinical and pathological differences are not as clear as might be expected, and the position of AsJ in relation to these two needs clarifying.

Since the last war there has been continued interest in the elucidation of problems deriving from various aspects of infective jaundice. The purpose of this paper is to present epidemiological and clinical information about IH and AsJ among service personnel in the last war.

### EPIDEMIOLOGY

An opportunity arose in Cyprus in 1942 for studying infective jaundice among six groups of troops over a period of one year. The groups comprised men and women from the United Kingdom, India and Cyprus, without syphilis and with syphilis under arsenical treatment. At that time little was known of the incidence of jaundice among the natives of the island. Inquiries revealed that a disease presumed to be IH occurred and that it was mild and sporadic with a low incidence. Patients suffering from it seldom visited a doctor, and in the villages the cause was commonly ascribed to a fright or shock suffered by the patient.\*

During the twelve months from 1st May, 1942, to 30th April, 1943, there were three more or less separate homogeneous military populations on the island, British, Indian and Cypriot. There was a certain amount of change within them, some British troops staying only four to six months, and Indians increasing in number after the first few months of the period. The monthly strengths of troops are given in Table I. Jaundice occurred in all troops, both those otherwise healthy and those undergoing arsenotherapy for syphilis. In the former there were good grounds for presuming the disease to be simple IH.

The numbers of British officers and other ranks contracting IH are given in Table II. No Cypriot officer or King's Commissioned Indian officer caught the disease, but the number at risk was small. The yearly attack rate among British officers was nearly three times, and the maximum rate (December) over three times, that for British other ranks. These unexplained findings are in accord with those for other parts of the Middle East during the war (McFarlan, 1945).

Calculation of the incidence of jaundice among healthy troops was a relatively simple matter, but it has been more difficult for patients receiving arsenotherapy where a period of only one year was being covered. It has been impossible to obtain precise figures, but a minimum incidence of AsJ can be determined. The numbers of patients on the only syphilis register in the island at No. 1 Combined Venereal Disease Treatment Centre are given in Table III by months and for the year. Between 1st May, 1942, and 30th April, 1943, 68 different British troops, 269 Indian and 39 Cypriot were at various times receiving arsenotherapy. Except for those coming on the register during the last month of the period, these figures do not include those under treatment for less than three weeks. Such cases were few and their brief treatment was usually due to their departure from the island.

The monthly incidence of jaundice among the three racial groups is shown in Table IV and Figs. 1, 2 and 3. The figures are based on the dates of admission

\* It is of historical interest that in the earlier editions of Osler's textbook *The Principles and Practice of Medicine*, emotional disturbances were listed as a rare cause of catarrhal jaundice.

TABLE I.—MONTHLY STRENGTHS OF BRITISH, INDIAN AND CYPRIOT TROOPS IN CYPRUS IN THE PERIOD 1ST MAY, 1942, TO 30TH APRIL, 1943, EXCLUDING SMALL NUMBERS IN HOSPITALS

Effective strength as at—	British		Indian (a)		Cypriot	
	Officers	Other Ranks	Officers	Other Ranks	Officers (b)	Other Ranks
May 2, 1942 ... ..	495	5,394	143	7,017	40	1,721
May 30 ... ..	513	5,416	163	7,226	38	1,412
June 27 ... ..	471	5,159	214	7,484	40	1,550
August 1 ... ..	612	6,071	298	11,917	47	1,661
August 29 ... ..	521	4,390	283	11,141	50	1,761
October 3 ... ..	562	4,798	370	13,070	50	1,816
October 31 ... ..	585	4,837	376	13,581	48	2,222
November 28 ... ..	574	4,814	323	12,122	49	2,177
January 2, 1943 ... ..	612	5,336	302	11,796	48	2,154
January 30 ... ..	587	4,723	270	11,167	49	2,234
February 27 ... ..	649	5,405	277	11,979	50	2,184
April 3 ... ..	643	5,398	272	11,998	57	2,054
Average monthly effective strength ... ..	569	5,145	274	10,875	47	1,912
Add average monthly strength of Royal Naval officers and men ... ..		27				
Add approximate average monthly strength of R.A.F. officers and airmen crew ...		65 (c)				
Add estimated average monthly strength of R.A.F. airmen (ground) ... ..		400 (d)				
Total average monthly strengths ... ..	569	5,637	274	10,875	47	1,912
	6,206		11,149		1,959	

(a) Including followers.

(b) An unknown proportion of these officers were British.

(c) Official service figure.

(d) Estimate based on known R.A.F. admissions to hospital being approximately 8 per cent. of total R.A.F. personnel.

TABLE II.—INFECTIVE HEPATITIS IN BRITISH OFFICERS AND OTHER RANKS

Month	Officers		Other Ranks		Totals
	Numbers	Per 1,000 average monthly strength	Numbers	Per 1,000 average monthly strength	
May, 1942 ... ..	0	—	6	4.1	6
June ... ..	1	1.8	6	1.1	7
July ... ..	2	3.5	11	2.0	13
August ... ..	3	5.3	11	2.0	14
September ... ..	5	8.8	14	2.5	19
October ... ..	6	10.6	23	4.1	29
November ... ..	7	12.3	11	2.0	18
December ... ..	8	14.1	24	4.3	32
January, 1943 ... ..	6	10.6	18	3.2	24
February ... ..	2	3.5	10	1.8	12
March ... ..	0	—	4	0.7	4
April ... ..	1	1.8	7	1.2	8
Totals ... ..	41	72.3	145	26.0	186

to hospital which were comparable. When the three groups are added together (Fig. 3) it is seen that there is a lag of between two and three months in the rise and fall of AsJ in relation to IH. The extent and variation of the incidence of IH in British troops was within the limits usually found in the Middle East during the war (official Service statistics and McFarlan. 1945). The incidence rose from a low level in May, 1942, to a peak of 0.52 per cent. in December, thereafter falling rapidly. Two-thirds of the British cases occurred between September, 1942, and January, 1943, inclusive. Among the Indians and Cypriots no such clear-cut wave was found. Only ten Cypriot cases occurred, an incidence for the year of 0.51 per cent. compared with 3.1 per cent. for the British. The monthly incidence among the Indians was low and relatively constant and the yearly rate was 0.55 per cent., almost the same as for the Cypriots. The yearly attack rates of all types of jaundice in Indians throughout the Middle East in 1942 and 1943 were respectively 0.324 per cent. and 0.586 per cent., and in both years the monthly flow of cases showed a similar uniformity (Service statistics). Spooner (1943) has commented on the relative insusceptibility of Indians to IH in the Middle East in 1942. The figures for IH among the British included four cases who had two attacks on the island within the period, each attack counting as one case. One Indian died of IH and constituted the only death from this condition.

As will be seen from Table IV, the incidence of jaundice in those undergoing anti-syphilitic treatment was 32.3 per cent. for British troops, 18.2 per cent. for Indian and 10.3 per cent. for Cypriot. There were several factors which indicated that jaundice among these groups may have been higher. Except among the Indians, seldom more than half the totals for the whole period were receiving arsphenamine in Cyprus in any one month. The reasons were that at varying times after the start of the period some patients left the island, arrived

TABLE III.—TOTALS FOR THE MONTH AND THE YEAR OF DIFFERENT TROOPS ON THE SYPHILIS REGISTER DURING THE PERIOD 1ST MAY, 1942, TO 30TH APRIL, 1943

Month	British	Indian	Cypriot
May, 1942 ... ..	23	50	9
June ... ..	23	58	11
July ... ..	28	79	13
August ... ..	33	117	16
September ... ..	37	163	22
October ... ..	33	174	23
November ... ..	35	187	21
December ... ..	34	201	20
January, 1943 ... ..	32	201	19
February ... ..	29	205	20
March ... ..	25	213	22
April ... ..	25	216	22
Monthly average on syphilis register ...	29.8	155.3	18.2
The number of different troops on syphilis register in the period ...	68	269	39

TABLE IV.—THE INCIDENCE OF IH AND AsJ IN DIFFERENT RACIAL GROUPS

Month	British				Indian				Cypriot				Total IH cases	Total AsJ Cases	Total infective jaundice cases
	IH		AsJ		IH		AsJ		IH		AsJ				
	No. of cases	Per 1,000 average monthly strength	No. of troops on register for the period*	Per 1,000 troops on syphilis register for the period*	No. of cases	Per 1,000 average monthly strength	No. of cases	Per 1,000 troops on syphilis register for the period*	No. of cases	Per 1,000 average monthly strength	No. of cases	Per 1,000 troops on syphilis register for the period*			
May, 1942	6	0.97	0	—	5	0.45	0	—	0	—	0	—	11	0	11
June	7	1.1	1	14.7	3	0.27	0	—	0	—	0	—	10	1	11
July	13	2.1	0	—	4	0.36	0	—	1	0.51	0	—	18	0	18
August	14	2.3	1	14.7	7	0.63	0	—	0	—	1	25.6	21	2	23
September	19	3.1	4	58.8	2	0.18	0	—	1	0.51	0	—	22	4	26
October	29	4.7	0	—	6	0.54	1	3.7	1	0.51	0	—	36	1	37
November	18	2.9	1	14.7	9	0.81	3	11.2	2	1.02	1	25.6	29	5	34
December	32	5.2	5	73.5	6	0.54	8	29.7	0	—	0	—	38	13	51
January, 1943	24	3.9	5	73.5	10	0.90	9	33.5	0	—	2	51.3	34	16	50
February	12	1.9	3	44.1	4	0.36	6	22.3	1	0.51	0	—	17	9	26
March	4	0.65	2	29.4	4	0.36	13	48.3	1	0.51	0	—	9	15	24
April	8	1.3	0	—	1	0.09	9	33.5	3	1.53	0	—	12	9	21
Totals	186	30.12	22	323.4	61	5.49	49	182.2	10	5.1	4	102.5	257	75	332

\* Incidence calculated from figures in the last line of Table II.

TABLE V.—COMPARISON OF THE INCIDENCE OF INFECTIVE JAUNDICE IN DIFFERENT GROUPS

Groups	Healthy troops/ syphilitics undergoing Arsenotherapy	British/ Indian	British/ Cypriot	Cypriot/ Indian
British ... ..	1/10.7			
Indian ... ..	1/33.2			
Cypriot ... ..	1/20.1			
Healthy troops ... ..		5.5/1	5.9/1	1/1.08
Syphilitics undergoing arsenotherapy ... ..		1.77/1	3.16/1	1/1.78

on the island, began their treatment, finished their treatment, became jaundiced and stopped treatment, or died. It was unfortunately not possible to obtain complete data about the first two categories. Further, 11 British, 7 Cypriot and 38 Indian troops were on the syphilis register for only two months of the year or less, including those who came on it during the last two months of the period. Clearly such individuals ran less risk of contracting jaundice in Cyprus within the period than others who were longer under treatment. On the other hand, some of the patients may have been infected before arriving on the island.

The Indian figure for AsJ includes the two attacks of one patient recorded separately, and one death. It does not include one man with syphilis under treatment who died of acute hepatic necrosis without clinical jaundice and who will be referred to later. Only two officers, both British, were treated for syphilis during the period ; neither contracted jaundice.

It will be seen from Table V that healthy British troops were nearly six times more likely to contract IH than healthy Indians or Cypriots. AsJ in British troops was three times commoner than in Cypriots and nearly twice the Indian incidence. It was nearly twice as frequent in Indians as in Cypriots. AsJ among British troops was nearly 11 times, among Cypriots 20 times and among Indians 33 times greater than IH among similar groups of healthy men.

Troops undergoing arsenotherapy while engaged in work connected with the medical services had a higher incidence of jaundice than others with syphilis doing different work. There were only four British soldiers so engaged and all developed jaundice. One was in a Field Hygiene Section, one a nursing orderly at a general hospital, and two were driving ambulances and handling patients in an Ambulance Car Company. Among the Indians there were 33 men variously distributed in the medical services, but not all tending patients. Eight had been on the syphilis register for less than two months. Eleven (33 per cent.) developed jaundice. These had been on the register for two to ten months and all belonged to units handling patients. One had two attacks, here recorded as one case. This incidence is nearly twice the figure (18.2 per cent.) for the Indian syphilitic group as a whole and five times the rate (6.8 per cent.) for Indians with syphilis not in medical units. Of the British cases of IH which occurred in the period, 4.8 per cent. were among healthy men and women in medical units. The figure was 11.5 per cent. for similar Indians. These figures are probably higher than



would be expected. Damodaran and Hartfall (1944) in Malta found that about 6 per cent. of their cases of IH occurred in R.A.M.C. personnel. Unfortunately it is not possible to give the comparative incidence of IH in healthy medical and non-medical troops in Cyprus.

## CLINICAL ASPECTS

### *Introduction*

Numerous studies of IH and SH have been made, but the clinical features of AsJ have not been so closely investigated. In particular it has not often been possible to compare these different forms of virus hepatitis in the same population.

Stokes, Ruedeman and Lemon in 1920 gave a description of their clinical findings in AsJ. Lerman (1929) described a series of 61 cases of AsJ and concluded that catarrhal jaundice (IH) was a more severe disease. He considered his cases of AsJ mild although two died. In reviewing the literature he found that other workers, including Ruge, could find no important differences between the two conditions. Although he had previously agreed with these views, Ruge stated in 1932 that "on the whole jaundice after salvarsan ran a severer course than simple jaundice." Mortality in the latter was 0.11 per cent., but in the former 1.24 per cent. Wile and Sams (1934) did not consider AsJ a more severe illness, but mention two patients who died from it. Soffer (1937) described a

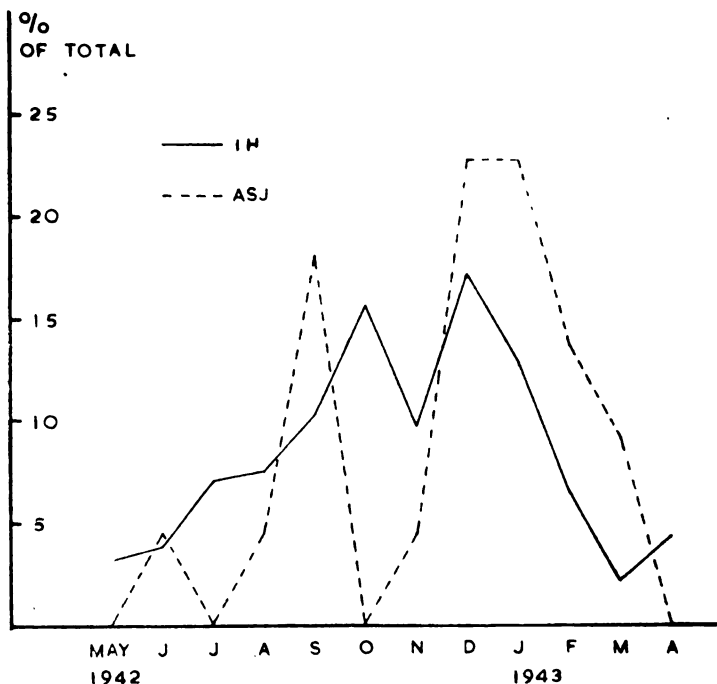


FIG. 1. SEASONAL INCIDENCE: BRITISH

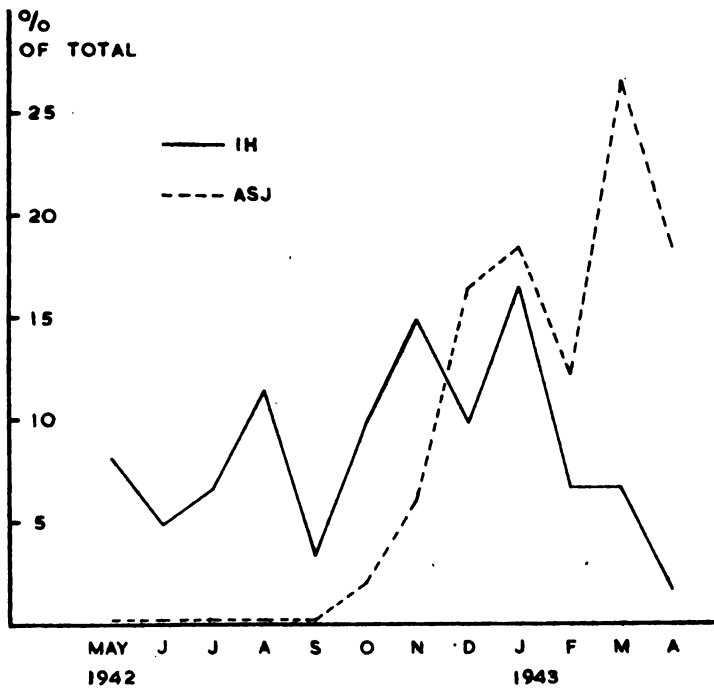


FIG. 2. SEASONAL INCIDENCE : INDIANS

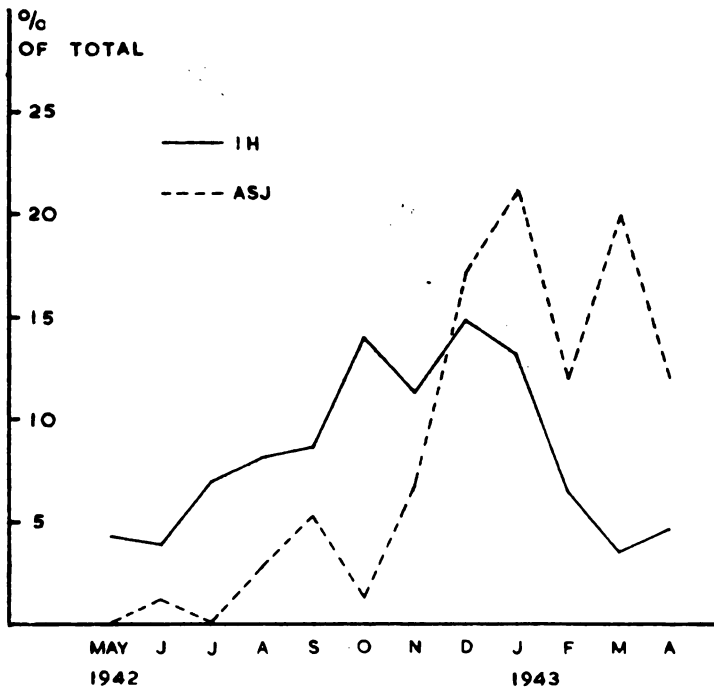


FIG. 3. SEASONAL INCIDENCE : ALL TROOPS

series of 158 patients with AsJ, and while he concluded that the disease usually ran a mild course and that it was indistinguishable from IH, some of his cases were jaundiced for upwards of 100 days and ten died of acute yellow atrophy of the liver (6.3 per cent.). Reviewing the literature, he found that the incidence of acute yellow atrophy in AsJ was from 1 to 14 per cent. in different series and that it was much commoner than among healthy people. Peters, Thompson, King, Williams and Nicol (1945) point out that AsJ may be very variable in its course in different patients, and that in some cases there are no symptoms either before or after the onset of jaundice. Mackay-Dick (1947) found that of 38 fatal cases of hepatitis, 36 were subjects undergoing arsenotherapy. Borensztejn (1948) noted that patients treated with arsenicals developed a more severe and fatal hepatitis than untreated subjects inadvertently inoculated simultaneously with presumed identical SH virus. Wilson (1951) found that AsJ was a more severe disease than IH.

In the case of SH the severity of the illness and the mortality vary widely in different reports. It has often been said that the condition closely resembles IH except for urticaria and arthralgias, but there are many instances where the illness has been more severe and the mortality much higher than is usually found in IH. The clinical issue between IH and SH is complicated by the variation in the picture presented by each disease at different times in different places. Thus during the last war in the Middle East those who saw large numbers of cases of IH would agree with Cullinan (1944) that the mode of onset and the course varied widely. Cases ranged from transient symptomless afebrile jaundice to severe fulminating or protracted hepatitis. The latter types of case were uncommon and in general IH ran no more than a moderate course, and the mortality was well below 1 per cent. In contrast there are reports of higher mortalities. Stokes and Miller (1947) described a form of hepatitis in Burma with a mortality of 2 per cent., which was five to six times the rate usually found there. However, their figures included some cases of AsJ. Bjørneboe, Jersild, Lundbaek, Thaysen and Ryssing (1948) reported an epidemic of IH starting in Denmark in 1941 in which the mortality was 37 per cent. In Burma the illness was fulminant and in males; in Denmark it was protracted and mostly in middle-aged women.

Where the literature records widely divergent findings in such closely related diseases it would be unwise to draw conclusions from a small series of patients such as are presented in this paper. Nevertheless, the cases which were studied in Cyprus tended to confirm that AsJ may be more severe than the naturally occurring IH at the same time and place. As there have been few comparisons of these two conditions under similar circumstances it is thought justifiable to place the findings on record.

#### *Arsenotherapy Jaundice in Cyprus*

The clinical manifestations of AsJ will be compared with those in IH occurring among the same troops in Cyprus between 1st May, 1942, and 30th April, 1943. During this period 14 British and Cypriot male patients with AsJ were

admitted to 82 General Hospital, and between 7th November, 1942, and 1st January, 1943, 30 consecutive British cases of IH were studied for comparative purposes. Altogether 116 cases of IH were seen at the hospital in the year under review.

### *Clinical Manifestations*

The first case of AsJ was admitted to hospital on 5th May, 1942, and the last on 7th January, 1943. Eleven were British and three Cypriot. The ages ranged from 21 to 33 years. Manifestations common in IH were present in most of the cases, namely, malaise, anorexia, nausea, vomiting, shivering, fever, abdominal pain, headache, jaundice, hepatic enlargement and tenderness, pale stools, biliuria and increase in urinary urobilinogen. In one patient the only manifestations were jaundice and slight hepatic tenderness. Some differences in degree and kind were apparent, and it is probable that in some the previous anti-syphilitic treatment affected the course of the illness. Most of the patients were under active anti-syphilitic treatment up to the time of the jaundice and, with the exception of one where it was unknown, the blood Kahn reaction was negative in all at the time of admission.

TABLE VI.—THE RELATION IN DAYS BETWEEN THE ONSET OF SYMPTOMS AND JAUNDICE AND THE LAST INJECTION OF ARSENICAL

Case	Symptoms	Jaundice
1	-10	+45
2	+2	+8
3	+4	+8
4	+28	+28
5	+3	+6
6	+4	+4
7	-7	-7
8	+1	+2
9	-1	+2
10	+8	+14
11	+12	+16
12	+5	+5
13	+30	+30
14*	+74	+76

\* First attack.

*Relationship of the Onset of Symptoms to the Last Injection of Arsenical.*—Table VI gives the intervals in days between the last injection of arsenical and the onset of symptoms and jaundice. A plus sign denotes that the latter appeared after the last injection and a minus that they appeared before. Cases 1, 7 and 9 had symptoms before their last injection; they were worse soon after it and were among those most ill.

*Mode of Onset and Course.*—The initial stages of IH are familiar. The mode of onset and course of AsJ may be different in some respects. In the first place we are dealing with patients who have been receiving a drug which, whatever its effect on the liver, is sometimes toxic to other parts of the body, especially

the nervous, hæmopoietic and vascular systems and to the skin. Secondly, prodromal manifestations are not uncommon (Peters *et al.*, 1945), and in this respect the disorder resembles SH. In the present series the mode of onset in two and the course in others was unlike IH. Some of the common symptoms, such as anorexia, behaved in an unusual manner.

**Jaundice.**—Under the conditions prevailing it was not possible to estimate the jaundice quantitatively, but the van den Bergh reaction was performed in many of the patients. It invariably gave a biphasic or indirect result. The depth and duration of the jaundice had to be judged by purely clinical means. It is recognized that this is not entirely satisfactory. There is difficulty in estimating the “end-point” in the skin and conjunctivæ, and it is believed that bile pigments may sometimes linger in the tissues after the serum bilirubin has returned to normal. Subsequent observations lead me to believe that this is not common.

TABLE VII.—THE DURATION OF THE JAUNDICE AND OF THE ILLNESS IN THE PATIENTS WITH ARSENOTHERAPY JAUNDICE

Case	Duration of jaundice	Duration of manifestations attributable to hepatitis	Total duration of illness
	Days	Days	Days
1	72 + (a)	72 + (a) (b)	191
2	56	62	62
3	91	94	137
4	34	62	75
5	36	39	39
6	69(c)	90	106
7	104	104	104
8	178 + (a)	178 + (a)	178 + (a)
9	78	103	103
10	66	72	72
11	31	35	35
12	68	68	68
13	65	132	132
14(d)	67	69	69
Average	72.5	84.3	98.0
IH Av. 30 cases	31.4 (12 to 76)	35.7	—

(a) Follow-up records incomplete.

(b) Pre-icteric phase excluded.

(c) First admission to hospital only.

(d) First attack.

The duration of the jaundice in the AsJ cases is recorded in Table VII. Clinically the jaundice lasted on the average over twice as long as in IH, but its depth was no greater and bore no relation to its duration nor to the severity of the illness. Case 8, although jaundiced for over 178 days, was never deeply so, and Case 1 was only mildly icteric in spite of persistent hepatomegaly. The

jaundice lasted from 31 to over 178 days with an average of 72.5 days. Cases 6 and 8 relapsed. In the first there was a short free period and the mild relapse occurred in conjunction with a mild attack of Flexner dysentery. In the other the jaundice never cleared and the sequence of events was of interest. He relapsed on 21st February, 1943. Sister B was tending the patient while she

TABLE VIII.—THE RELATION OF OTHER MANIFESTATIONS TO THE JAUNDICE

Case	Duration of symptoms before onset of jaundice :	Duration in days after the onset of jaundice of—		
		Anorexia	All other symptoms	Signs
1	Days	—	—	72+(a)
2	55	8	6	—
3	6	12	20	19
4	4	22	16	24
5	0	9	9	3
6	3	—	—	90
7	0	3	30	72
8	1	22	28(b)	178+(a)
9	3	12	14	99
10	6	—	2	49
11	4	6	7	24
12	0	17	17	62
13	0	On and off 95	On and off 132	132
14(c)	2	1	5	—
Average	2.2 (excluding Case 1)	14.8 (excluding Case 13)	20.4	58.9
IH Average 30 cases	4.8	5.3	5.7	18.2

(a) Follow-up notes incomplete.

(b) Primary attack only.

(c) First attack.

was, from 8th to 12th January, suffering from the initial symptoms of IH. This nursing sister had worked on the same general medical ward for two months before developing IH. During this period patients with the condition were admitted to the ward, but only one, Pte. F, was in the pre-icteric stage. This man was admitted on 10th December, 1942, febrile and severely ill, with tyrosine crystals in his urine. Peters *et al.* (1945) found an exacerbation or relapse rate of 6.8 per cent. in 468 cases of AsJ. Similar figures for IH are 1.5-18 per cent. (Neefe, 1946; Havens, 1948). Cameron (1943) noted two relapses in his 170 cases of IH within a month of discharge from hospital. This aspect is usefully discussed by Peters and his collaborators. They do not agree with Marshall (1944) that relapses are due to infection with IH, perhaps from patients in the same ward.

Case 1 presented features of interest. Although his liver was considerably

enlarged and must have been damaged, jaundice did not appear until nearly two months after the onset of his illness. It was mild in degree although lasting over 72 days. The jaundice may have been due to IH. On 8th May, 1942, a cook from the hospital kitchen, preparing food eaten by the patient, was admitted to the same ward with IH. Case 1 became jaundiced on 8th June for the first time, without other symptoms. The cook's illness began on 30th April and was typical. Jaundice appeared on 6th May, but he continued at work until admitted. There was no other member of the staff or patient with jaundice until 23rd June. Case 1 was not in contact with any other jaundiced subject for at least 40 days before the onset of his jaundice. It is possible that he caught the disease from the cook by direct contact or from food prepared by him. However, the jaundice appeared only 45 days after his last injection of arsenical and inoculation jaundice could not be excluded. At the time it was thought, that Cases 1 and 8 might be examples of infection with IH by droplet spread. It is now known that the intestinal route is at least as important as a means of infection (MacCallum and Bradley, 1944; Havens, 1946; MacCallum, 1951).

*Relationship of Other Manifestations to the Jaundice.*—In the series of 30 cases of IH the jaundice was asymptomatic in one and in the others symptoms appeared from 1 to 11 days before the jaundice, the average being 4.8. Anorexia lasted from 0 to 13 days (average 5.3) and other manifestations 0 to 72 days (average 18.2) after the jaundice had appeared.

Table VIII gives these details for the arsenotherapy cases. The symptoms and signs referred to are only those considered to be due to hepatitis except in the first column, which includes all manifestations. Definite prodromata were not a common feature and pre-icteric symptoms were often of shorter duration than in IH. The anorexia lasted longer and other manifestations were present for a long time. In Case 8 abdominal pain lasted for 27 days after the jaundice appeared. Nausea was experienced for one day when he relapsed. In a number of patients there were recurrences of anorexia and other features long after the jaundice had appeared. In Case 4 abdominal pain lasted for three days and after 14 days' freedom reappeared accompanied by shivering, mild fever and epigastric tenderness. The tenderness lasted 10 days and after a free interval of 16 days reappeared for a further fortnight. Recently Brodribb (1952) has described a relapsing course, which is rare, in cases of IH.

*Anorexia.*—There is rightly general insistence on the importance of this feature in the symptomatology of IH. It is usual for the appetite to be lost several days before the onset of jaundice and to return steadily soon after its appearance. Two of the 30 cases of IH and three of the 14 AsJ cases had no loss of appetite (Table VIII). Case 2 did not lose his appetite until two days after the jaundice. Case 4 had anorexia for two days after the jaundice and after an interval of 16 days for a further 20 days. Case 7 had surprisingly little anorexia considering the degree of gastro-intestinal disturbance (vomiting and hæmorrhage). In Case 13 the appetite was variable, never being normal for many days at a time. The average duration of anorexia after the appearance of

jaundice was 5.3 days in the cases of IH and 14.8 days (excluding Case 13) in patients with AsJ.

*Fever.*—As regards height and duration at the onset, the temperature was raised in much the same manner in the IH and AsJ cases. Fever was no commoner in one series than in the other. Case 7 had fairly high fever for the first five days in hospital and from his own statement for nine days in all at the onset. Continued fever up to 103° F. was occasionally seen at the onset of IH in the Middle East.

*Abdominal Pain and Discomfort.*—In the IH cases, 18 (60 per cent.) complained of upper abdominal pain, mostly epigastric and right-sided; three of much "wind"; one of "heaviness"; one of "wind" and heartburn; and one of a sensation in the epigastrium "like a blow on the solar." Six had no abdominal symptoms. Altogether 24 (80 per cent.) had discomfort of some kind in the abdomen and its duration varied from two to 14 days, average 7.3.

TABLE IX.—HEPATIC ABNORMALITIES

Case	Liver enlargement	Size of liver : Fingers-breadth	Duration of liver enlargement	Liver tenderness	Duration of liver tenderness	Duration from onset of illness of increase in urinary urobilinogen
1	+	3	Days 106+	+	Days ?(a)	—
2	—	—	—	—	—	—
3	+	0.5	3	—	—	—
4	—	—	—	+	24	—
5	—	—	—	+	3	—
6	—	—	—	+	3	90
7	+	3	38	+	33	72
8	+	1	58(a) (b)	+	177+(a)	179+(a)
9	+	2	80	+	97	57(c)
10	+	3	58	+	47	39
11	+	2	21	+	23	20
12	—	—	—	+	25	62
13	+	3	132	+	132	63
14(d)	—	—	—	—	—	Not done
Total % Average	8 57.1		35.4	11 78.5	40.3 (excluding Case 1)	73.0(e)
Corresponding figure 30 cases IH	36.7%		3.3	60.0%	11.2	16.3

(a) Follow-up notes incomplete.

(b) Enlargement first noted on the 115th day of illness, at time of relapse.

(c) Increase first found three weeks after the onset. Thereafter there were considerable quantities which later fluctuated.

(d) First attack.

(e) Figure for Cases 6-13 only.



Of the AsJ cases there were eight (57 per cent.) with abdominal pain and one with discomfort, a total of 64 per cent. with abdominal symptoms. In four the pain lasted between three and six days. In Case 8 the pain lasted four days initially and returned later for a further 11 days. In Case 9 the pain lasted 16 days. It was difficult to judge the significance of the pain in Case 13 since it appeared several weeks before the jaundice. He continued to have intermittent pain up to the time he ceased to be under observation (over 130 days). In five the duration was a little above the average in the IH series (7.3 days), but the average for the group (excluding Case 13) was not raised (5.5 days).

*Hepatic Enlargement, Tenderness and Dysfunction.*—Eleven cases of IH (36.7 per cent.) had enlarged livers varying between one and two fingers-breadth below the costal margin in the right hypochondrium on full inspiration, lasting up to 22 days. Eighteen (60 per cent.) had tenderness of the hepatic area of up to 64 days' duration.

TABLE X.—SUMMARY OF GROUP DIFFERENCES

Manifestations							IH	AsJ
Jaundice. Average duration ... .. Days							31.4	72.5
Anorexia. Average duration after the onset of the jaundice Days							5.3	14.8
Average duration of symptoms after the onset of jaundice Days							5.7	20.4
Average duration of all manifestations after the onset of jaundice Days							18.2	58.9
Liver	Enlargement. Average duration ... .. Days						3.3	35.4
	Tenderness	Average percentage incidence ... ..					60.0	78.5
		Average duration ... .. Days					11.2	40.3
	Average duration from onset of illness of increase in urinary urobilinogen ... .. Days						16.3 (22 cases)	73.0 (8 cases)
Abdominal tenderness other than hepatic. Average percentage ...							10	28.6
Urine	Albumin. Average percentage incidence ... ..						33.3	64.3
	R.B.Cs. Average percentage incidence ... ..						3.3	28.6
	Casts. Average percentage incidence ... ..						3.3	14.3
Bleeding and bruising other than epistaxis and hæmaturia. Average percentage incidence ... ..							0	14.3
Length of illness due to hepatitis ... .. Average days							35.7	84.3

Table IX shows the details of the various hepatic signs in the AsJ cases. There are several differences compared to IH. More patients suffered from hepatic enlargement and its degree was sometimes greater. Its duration was considerably longer in seven of the eight with this feature, varying up to over 132 days. 78.5 per cent. had hepatic tenderness compared with 60 per cent.

in the series of IH, and its average duration was longer. A curious feature was that in four of the AsJ cases there was a return of the hepatic tenderness after it had cleared. In Case 7 there were two such returns. In Case 8 the tenderness reappeared when he relapsed and in this patient there were altogether three returns. In Case 4 this sign persisted for 15 days after the jaundice had gone, and in Case 13 for very much longer. Despite considerable hepatic enlargement in Case 1, the liver was not tender on palpation until after evacuation to another hospital.

Urines were examined for urobilin (Schlesinger's method) or, more commonly, urobilinogen (Ehrlich's aldehyde reagent) by a modification of the method of Stitt, Clough and Clough (1938). Urine was diluted one in ten before the addition of Ehrlich's reagent so that some degree of quantitative measurement was obtained. Urobilinogen was considered to be present in increased quantity if a colour deeper than a pale pink was obtained. Of the 22 cases of IH whose urines were tested for urobilin or its precursor, 20 were found with increased amounts. The increase lasted on an average for 16.3 days from the onset of the illness. The longest was for more than 66 days (Pte. F, a severe case), one for 38 days, and the rest for less than 20. The increase was therefore not long maintained in most cases and it was not usually large. Of the eight AsJ cases who were examined, all showed an increase in urinary urobilinogen. In seven it was found in large amounts in the urine for long periods after the onset of the illness, and the average duration for the eight cases was 73 days. In Cases 8, 9 and 12 the quantity varied. A similar fluctuation was noted sometimes in IH, in which it has been observed by others (Lindberg and LeRoy, 1947).

*Non-hepatic Abdominal Tenderness.*—Four cases of AsJ (30.8 per cent.) had abdominal tenderness elsewhere than over the liver. This feature was found in 10 per cent. of the IH patients and appears to be not uncommon (Wilson, 1951).

*Splenomegaly.*—Of the 30 cases of IH, only one had splenic enlargement, an uncommonly low incidence. Among the AsJ patients, four had enlarged spleens and in one the organ was tender for a time. These patients denied previous malaria.

*Urinary Abnormalities.*—Bile was found in the urine of all cases of both groups. In the series of IH, ten (33 per cent.) had albuminuria. In eight it was mild and in two moderate in degree. It lasted for no more than a few days in all except one, whose urine still contained albumin after 15 days. In one case moderate numbers of red blood cells were found in the urine and in another (Pte. F.) granular casts were present. Of the AsJ cases, nine (64 per cent.) had albuminuria. In six it lasted between 10 and 40 days and bore no relation to pyrexia. In Case 1, after persisting for 40 days, the albumin disappeared just before he became jaundiced. Moderate numbers of red blood cells were found in the urines of four patients. In Case 1 they were present during the long pre-icteric stage and were probably merely part of the hæmorrhagic state.

Granular casts were found in the urines of two patients. Observations on urinary abnormalities have been made by others. Strathy, Smith and Hannah (1920) reported albuminuria in most of eight fatal cases and in 28 of 50 non-fatal cases of "delayed arsenical poisoning." Lerman (1929) found hyaline and granular casts in the urine of more than half his 61 cases of AsJ. Lucké and Mallory (1946) found casts in the urine of half their 196 cases of fatal virus hepatitis (including cases of SH), and albumin was present in two-thirds.

*Changes in the Blood.*—Except for a mild leucopenia in the early stages of the disease, a mild or moderate monocytosis and the presence of a limited number of plasma or Türck cells, there are few changes in the cytology of the blood in IH (Miles, 1951). Anæmia was not seen in the cases under review, and the state of the platelets and capillaries was not investigated. Mild increases in the blood coagulation and bleeding times were accounted for by the jaundice. Hæmorrhage is uncommon in IH and is usually confined to epistaxis and occasional hæmaturia. Purpura, bleeding gums and intramuscular hæmorrhages were reported as unusual occurrences in the Middle East Forces. Whitesell and Snell (1949) have described ten cases of acute hepatitis (presumably virus); in five the platelets were reduced to 70,000-115,000 per c.mm. by the direct method and seven showed increased capillary fragility. Jones and Evans (1951) have described a case of IH in this country where the platelets dropped to a low level in association with purpura.

Blood findings in the IH and AsJ cases did not differ notably. The platelets were reduced in number in two patients with AsJ. In Case 9 they numbered 128,000 per c.mm. (direct method), and in Case 1 they were low for five weeks, going below 50,000 per c.mm. These two passed red cells in their urine longer than the others. Cases 1 and 7 had significant bleeding. In Case 7 the white blood cells numbered 4,000 per c.mm. at first, later rising to 14,800. This contrasts with Pte. F. (severe IH), whose white blood cells numbered 14,000 at the onset (16 per cent. Türck cells). The platelets in Case 7 numbered 205,000 per c.mm. and the coagulation time was twelve minutes (Mas y Magro). This patient had a slight hæmatemesis and considerable melæna, but the capillary resistance test on the arm was negative. Case 1, who showed bruising and considerable bleeding from the gums, had a positive capillary resistance test with a normal coagulation time (one and three-quarter minutes). These manifestations were present a month before he became jaundiced and must have been due to capillary damage or lack of platelets, or both. In this case the leucocytes were not reduced. It is likely that the bleeding was due to capillary damage, for the platelets were progressively reduced in number and remained at a low level after the bleeding had stopped (Macfarlane, 1941). Falconer and Epstein (1940) found that purpura might appear after a few doses of arsenical or after prolonged treatment, this being commoner. Thrombocytopenia was present in five of their six cases. Blood dyscrasias in arsenotherapy are discussed by Laird (1942), Ferguson (1944) and Nelson (1952), who contribute cases of their own. Blood disorders are rare in arsenotherapy, but of those which occur,

thrombocytopenia unaccompanied by agranulocytosis or aplastic anæmia seems the commonest. In contradistinction to others it carries a good prognosis, although fatal cases are reported, for example that of Lewis (1944).

*Manifestations due wholly or in part to the Arsenotherapy.*

**Loss of Weight.**—Two patients (Cases 1 and 7) had obviously lost weight during their anti-syphilitic treatment and both gained weight clinically in hospital. Sicard, Hagenau and Kudelski (1919) considered that weight was likely to be lost after a moderate amount of arsenotherapy and this observation has received general assent. Analysing 52 cases of AsJ, Stokes *et al.* (1920) found a loss of up to nine pounds in weight during the prodromal period in 45 per cent. Fowler (1948) recorded the interesting finding that of 64 patients who developed AsJ, 56 showed a weight loss of two pounds or over seven to ten days before bile appeared in the urine. He found two patients who lost weight gradually over many months, but in most cases the loss was confined to the late part of the prodromal stage of the hepatitis, so that it may have been partly due to this and not purely a manifestation of the arsenotherapy.

**Skin Eruptions.**—Two patients were admitted with early exfoliative dermatitis and five later developed dry or greasy scaly circinate lesions, varying in size from a half to one inch, on limbs and trunk, simulating seborrhœa. Although there were relapses, the eruptions finally disappeared with treatment for this condition. These lesions appeared a long time after the cessation of arsenotherapy. Stokes, Beerman and Ingraham (1944), discussing the skin reactions of arsenicals and bismuth, do not describe seborrhœa-like lesions.

**Peripheral Neuritis.**—Paræsthesiæ were noticed by Cases 1 and 8. Knee and ankle jerks were sluggish or lost in these two and in five others. In some they became brisker under observation. In none was there evidence of syphilis of the nervous system. Arsenical peripheral neuritis with motor loss is rare, but mild disturbance of reflexes in the lower limbs is common during arsenotherapy. Minor changes of this kind have been recorded by Sicard *et al.* (1919) and Stokes *et al.* (1944). Neurological complications have been described in IH, but they are not usually like those seen with arsenotherapy. Lescher (1944) has described a woman with polyneuritis, Mackay-Dick (1944) a soldier with paralysis of the recurrent laryngeal nerve, and Stokes, Owen and Holmes (1945) include peripheral neuritis in their classification of the neurological complications of IH.

*Manifestations after Previous Arsenotherapy.*

Nine gave histories of reactions varying from mild faintness to marked malaise and depression. Case 8 suffered malaise, headache, nausea, shivering and feverishness on many occasions. Case 3 had a few mild reactions after the early injections of the first course and again after the first injection of the second when mild transient jaundice was noted a week later. This was seven months prior to the subsequent hepatitis and occurred at a time when there was very

little jaundice in Cyprus. Treatment was not interrupted. The series was too small to justify deductions as to a general relationship between these reactions and subsequent hepatitis, but Cases 2 and 11 gave histories of increased reactions to arsenicals for the last five weeks of the incubation period of the hepatitis.

#### *Duration of the Illness*

In the series of IH, jaundice was the last feature to go in all but one where hepatic enlargement persisted. Among the AsJ patients, the last manifestation to disappear was the jaundice in six, hepatic enlargement and tenderness in two, and skin lesions in three. In some patients other manifestations outlasted the jaundice by many weeks. The duration of illness, including all symptoms and signs, varied from 35 to 191 days, the average being 98 (Table VII). Taking the manifestations attributable to the hepatitis only, the duration was 35 to 178 + days, average 84.

#### *Summary of Findings in the AsJ Cases*

Three patients suffered from symptoms before their last injection of arsenical, which made them worse, and they were among those most severely affected. The mode of onset was unusual in two. For nearly two months before the jaundice appeared in Case 1 the liver was considerably enlarged and there were signs of arsenical intoxication. In Case 7 intestinal hæmorrhage was an early feature. The symptomatology and course were unusual in Case 13. Fever was not common, but anorexia and other features lasted a long time after the jaundice appeared and returned for variable periods during the illness. Jaundice lasted for a long time in most of the patients. Abdominal pain and tenderness, whether related to the liver or not, was common. Hepatic enlargement was considerable and abdominal and hepatic manifestations lasted for a long time in most of the patients. Urobilinogen excretion in the urine indicated a prolonged hepatic dysfunction. Albumin, red cells and casts were noted rather frequently in the urine, and two patients showed hæmorrhagic manifestations. The illness was prolonged and in several of some severity. Loss of weight, skin eruptions, mild peripheral neuritis and manifestations during previous arsenotherapy were considered to be due wholly or in part to arsenical administration.

#### *Group Differences between IH and AsJ*

The chief differences between the 30 cases of IH and the 14 of AsJ are set out in Table X. Some were more marked than others. The most striking were the duration of the jaundice, anorexia and other manifestations, the duration of enlargement and tenderness of the liver and of hepatic dysfunction, the incidence of abdominal tenderness elsewhere than in the hepatic area, urinary abnormalities, bleeding manifestations, and the length of illness. The mode of onset was sometimes different in the cases of AsJ, among whom there was a higher proportion of ill patients. The differences between the two series indicate that AsJ gave rise to a more severe illness than IH in Cyprus at the time

in question, but that otherwise as a group the clinical features were not sufficient to differentiate them.

### *Anti-syphilitic Treatment*

The administration of arsenicals was stopped on admission to hospital in all the AsJ cases. General opinion in the Middle East was that arsenicals should not be given until at least three months after an attack of AsJ. Treatment was often continued in the meantime with bismuth. Case 14, the only patient in this series to receive further arsenotherapy within three months of recovery, had a further attack of jaundice. His case was instructive. After apparent recovery from AsJ he began a second course of arsenotherapy elsewhere 25 days after the jaundice had cleared. This course was completed within two months. Nearly two months later he suffered a severe attack of jaundice and was eventually invalided from the army with an enlarged, tender liver.

(To be continued)

# WOUND CONTAMINATION AND WOUND INFECTION\*

BY

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ALTHOUGH the following investigation of war wounds was conducted with particular reference to the suturability of wounds, it involved a comprehensive study of wound contamination and of those factors concerned in the development of wound infection. The effect of chemotherapy and penicillin was also investigated. Material was collected and observations made in Italy, from April, 1944, to March, 1945, at several base hospitals, field dressing stations, casualty clearing stations, and one field hospital.

This report represents a summary of part of the work done by No. 1 Research Laboratory, R.C.A.M.C., Canadian Army.

## MATERIAL AND METHODS

During the period of this investigation, the policy with regard to the treatment of soft tissue wounds was early débridement, at the field dressing station, casualty clearing station or field hospital, with subsequent transfer of the patient to a base hospital for suture of the wound. Chemotherapy was usually begun during transport to the place where primary débridement was done, and consisted of approximately 1 gram to 1½ grams of oral sulfanilamide. Penicillin was only available for selected cases during the first six months of the investigation.

In this series of over 1,000 wounds, compound fractures are not included, except in a few instances where a soft tissue wound was complicated by a minor fracture, and in one series where the effect of early penicillin therapy was studied.

## GENERAL PROCEDURE

Swabs were taken in every instance by an officer of the research unit, care being taken to contact every available part of the wound. These were planted on suitable isolation media within one hour of taking. The routine media used for this purpose were blood agar plates containing 5 per cent. of citrated human

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\* This report has been condensed and rewritten by John D. Hamilton from the original reports which appeared in the *Proceedings of Eighth Meeting of the Associate Committee on Army Medical Research*, Volume 2, Reports of No. 1 Research Laboratory, National Research Council of Canada, Ottawa, December, 1945.

blood, and a cooked meat medium of the Robertson's meat mash type, but modified by the addition of 0.1 per cent. dextrose, 0.01 per cent. sodium thioglycollate, and 0.05 per cent. agar. The inoculated media were incubated at 37° C. for 18 to 24 hours when colonies from the blood agar plates were picked for identification. At this time the cooked meat medium was streaked on a fresh blood agar plate to look for further colony types. In many instances several replatings were done at 24-hour intervals.

The importance of the cooked meat medium soon became obvious. It supported good growth of most aerobes and anaerobes, and was extremely useful where the original plate was overgrown with *Proteus* or other spreading organisms. The replatings were of great value in checking the accuracy of the initial blood plate, but more particularly in revealing the presence of additional micro-organisms which were not found on the primary plate. In many instances saprophytic types predominated on the initial plates, and the true bacterial picture of the wound became evident only after further search. In a series of 688 wounds, a week or more old, additional micro-organisms were isolated from the cooked meat in 325 (47 per cent.) and additional pathogens in 75 (11 per cent.). In another series of 209 wounds, a week old or less, additional micro-organisms were found in 146 (76 per cent.) and additional pathogens in 16 (8 per cent.). There were no instances in either series where the organisms found on the original blood plate were not recovered from the cooked meat.

#### *Identification and Classification of Micro-organisms*

1. Staphylococci were classed as "pyogenic" or "non-pyogenic" on the basis of their ability to coagulate oxalated human plasma. Such plasma was diluted 1 : 4 with saline, dispersed in tubes in 0.5 c.c. amounts, and the test read after incubation at 37° C. for 4 hours following heavy seeding with the test organism.

2. Streptococci were classified as beta hæmolytic, alpha hæmolytic, or non-hæmolytic according to hæmolytic effects of surface growth on blood agar together with colony appearance and morphology.

3. Micrococci included all Gram-positive cocci not classifiable as staphylococcus or streptococcus. All were coagulase negative.

4. Coli-aerogenes bacilli were differentiated only by their saccharolytic properties, indole reactions, and Voges-Proskauer reactions (O'Meara's test).

5. *Proteus*. All organisms designated as such were the rapidly spreading types of Gram-negative bacilli. Their presence in specimens provided many difficulties in the separation and isolation of other organisms. This was usually accomplished by the use of various replating techniques, including: (a) The incorporation of sodium azide in the plating media; (b) the flooding of blood agar plates with alcohol followed by drying in the incubator; (c) the mere drying of blood agar plates for one or more hours in the incubator; (d) the use of surface dried blood agar plates containing 6 to 8 per cent. agar was of particular value.

6. *Pseudomonas aeruginosa* (pyocyaneus) was identified by its general growth characters, particularly pigment production.



7. Other Gram-negative, non-sporulating aerobic bacilli were separated from the *Escherichia* and *Aerobacter* and from each other by their growth characters and saccharolytic properties. As with the separation of all Gram-negative aerobic bacilli, the distinguishing tests were inadequate for precise identification, but they allowed a crude practical division of the groups.

8. Diphtheroids. These were the small Gram-positive, non-sporulating aerobic rods. None was *C. diphtheriae*.

9. *B. subtilis*. This includes all aerobic, Gram-positive sporulating bacilli.

10. The Clostridia were isolated by plating on blood agar from the cooked meat tubes, usually after 48 hours. These plates were incubated in anaerobic jars for 18 to 24 hours or more, at which time colonies were picked to cooked meat for identification. Replatings were frequent. In most instances, particularly where stained smears of the cooked meat showed organisms resembling Clostridia, or where gas and an offensive odour had been produced, the cooked meat was heated at 80° C. for 10 minutes, seeded heavily to a fresh cooked meat tube, and this latter plated on blood agar after suitable incubation. This method has obvious defects, and strains late in forming spores may have been lost.

The scheme of identification of Clostridia was based largely on that given in Bergey's *Manual of Determinative Bacteriology*.<sup>\*</sup> Morphological features as seen in young cultures on plain nutrient agar were studied as well as colony forms. Saccharolytic properties were determined using Hiss' serum waters containing glucose, sucrose, lactose, maltose, mannite, salicin, and glycerol. Proteolytic properties were assessed using tryptone water, iron acetate medium, gelatin, litmus milk, and Loeffler's serum slopes. Use was made of various species' peculiarities such as the stormy fermentation of milk, and the target colony hæmolysis of the Welch bacillus. Unfortunately experimental animals to determine pathogenic effects and sera for neutralization tests were not available.

### *Penicillin Sensitivity Tests*

Tests for penicillin sensitivity were done on all aerobic micro-organisms. A ditch plate method was employed using nutrient agar plates and a penicillin solution containing 5 units per c.c. The plates were read after incubation for 24 hours, and all plate tests were controlled by the use of the standard Oxford strain of staphylococcus.

### THE BACTERIAL FLORA OF WAR WOUNDS

As stated above, nearly every casualty included in the investigation had received small doses of oral sulfanilamide before primary surgery was done. Following primary débridement, most cases received a course of sulfathiazole totalling about 5 grams.

In Table I, the bacterial flora in two groups of open wounds is given. The young wounds include those wounds in which the culture was taken immediately

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<sup>\*</sup> Bergey's *Manual of Determinative Bacteriology*, 5th ed., 1939, Baltimore.

prior to primary débridement, which was within an average of 15 hours after wounding, while the old wounds include those which had been transferred to a base hospital for delayed suture after primary débridement at a forward surgical centre. The age of this latter group varied from 5 to 20 days, averaging about 10 days after wounding.

The bacteria isolated have been divided into pathogens, wound pathogens, saprophytes and anaerobes.

TABLE I.—BACTERIAL FLORA OF TWO GROUPS OF WOUNDS OF DIFFERENT AGES

Bacterial flora	Young wounds : Total number, 109		Old wounds : Total number, 300	
	Number	Per cent.	Number	Per cent.
A. None ... ..	12	11	38	13
B. True Pathogens				
<i>Staphylococcus pyogenes</i> ... ..	26	24	134	45
<i>Streptococcus hæmolyticus</i> ... ..	12	11	27	9
C. Wound Pathogens				
<i>Ps. æruginosa</i> ... ..	2	1.8	62	21
<i>Proteus</i> ... ..	1	0.9	20	7
D. Saprophytes				
Non-pathogenic staphylococcus ...	44	40	80	27
Micrococcus ... ..	26	24	29	10
<i>Streptococcus viridans</i> ... ..	19	17	16	5
Non-hæmolytic streptococcus ...	18	16	53	18
Diphtheroids ... ..	22	20	57	19
<i>B. subtilis</i> group ... ..	40	37	73	24
<i>E. coli</i> ... ..	3	3	20	7
Coliforms ... ..	18	16	31	10
Aerobacters ... ..	5	4	16	5
Achromobacters ... ..	18	16	44	15
Alkaligenes ... ..			1	0.3
E. Anaerobes				
<i>Cl. perfringens</i> (Welchii) ... ..	21	20	12	4
<i>Cl. bifermentans</i> ... ..	7	6	3	1
<i>Cl. œdematiens</i> ... ..	1	0.9	3	1
<i>Cl. septicum</i> ... ..			1	0.3
<i>Cl. histolyticum</i> ... ..	2	1.8	2	0.7
<i>Cl. sporogenes</i> ... ..			7	2
<i>Cl. cochlearium</i> ... ..			2	0.7
<i>Cl. tertium</i> ... ..	2	1.8	1	0.3
<i>Cl. chauveii</i> ... ..			1	0.3
<i>Cl. tetanomorphum</i> ... ..	1	0.9		
Unidentified Clostridia ... ..			9	3

(a) *Pathogens.* The classification of *Staphylococcus pyogenes* and *Streptococcus hæmolyticus* as true pathogens will not be questioned. In the analysis of wound healing which follows, it will be seen that the *Staphylococcus pyogenes* is principally responsible for wound infection and delayed wound healing. In Table I a marked difference in incidence of *Staphylococcus pyogenes* is evident in the two groups of wounds studied, in that it was isolated from 24 per cent. of young wounds and 45 per cent. of old wounds. In Table II the increasing

incidence of this organism with the age of the wound can be seen in another group of 590 wounds.

TABLE II.—INCIDENCE OF *Staphylococcus pyogenes* IN WOUNDS OF INCREASING AGE

Age of wounds	Number of wounds in each series	Incidence of <i>Staphylococcus pyogenes</i>	
		Number	Per cent.
Less than 24 hours ... ..	167	35	21
1 to 5 days ... ..	84	25	30
5 to 10 days ... ..	244	93	38
10 to 15 days ... ..	41	26	63
15 to 20 days ... ..	28	19	68
Over 20 days ... ..	26	19	73
Total ... ..	590	217	37

This increasing incidence of *Staphylococcus pyogenes* may be interpreted in at least two ways. The staphylococci may have entered the wounds at the time of injury. According to Cruikshank\* about 15 to 20 per cent. of healthy individuals are skin carriers of *Staphylococcus pyogenes*. This corresponds fairly well with the basic incidence of 21 to 24 per cent. given in Tables I and II. Indirect evidence may be given to support the thesis that the higher incidence in older wounds is due to contamination by attendants, from reservoirs of infection present in hospital wards, and possibly from the nose and throat of the individuals themselves, since about 50 per cent. of the normal population are nasal carriers of *Staphylococcus pyogenes*. In our base hospital different procedures were practised in two different surgical wards. In one a minimal exposure of wounds was rigidly adhered to. In the other dressings were frequently changed, especially during ward rounds. The relative incidence of *Staphylococcus pyogenes* in these two wards, as given in Table III, shows striking differences, being 35 per cent. in one as opposed to 65 per cent. in the other.

TABLE III.—INCIDENCE OF *Staphylococcus pyogenes* IN WOUNDS IN DIFFERENT WARDS

Type of ward	Number of wounds examined	Incidence of <i>Staphylococcus pyogenes</i>	
		Number	Per cent.
Service where wounds frequently examined ...	113	73	65
Service where wounds not examined ... ..	287	101	35
Total ... ..	400	174	44

Size of the wound did not appear to have any relationship to the incidence of *Staphylococcus pyogenes*. In 30 older wounds less than 2 inches long 32 per cent. contained *Staphylococcus pyogenes*. In 47 older wounds more than 6 inches in length 40 per cent. contained *Staphylococcus pyogenes*.

\* Cruikshank, R., "The Epidemiology of Skin Infections," *Brit. Med. J.*, 1953, **1**, 55-59.

(b) *Wound Pathogens*. The two organisms in this group, *Pyocyaneus* and *Proteus*, were labelled wound pathogens because of their ability to produce pus in wounds and delay wound healing. Neither organism had any invasive power and produced a mild local inflammation, principally in the more complex wounds in which débridement had been incomplete or impossible, and in which retained dead tissue, blood clot or pooled serum formed a suitable medium for growth of these bacteria. The increased incidence in older wounds, shown in Table I, could possibly be related to hospital cross-infection. In our base hospital with large 200-bed surgical wards the incidence of *Ps. aeruginosa* rose to 30 per cent. of 158 wounds. When this same hospital moved to a new location, and new wards were opened, the incidence of *Ps. aeruginosa* was found to be 2 per cent. in a comparable series of 262 wounds. An attempt to correlate the presence of wound pathogens with size and location of wound was unsuccessful. There did, however, appear to be some correlation with the type of wound. As mentioned above, the complicated poorly drained wound appeared to have a higher incidence of wound pathogens than the simple well-débrided and well-drained wounds.

(c) *Saprophytes*. None of the organisms in this group appeared to play any part in the development of infection or in delayed healing. There was not any marked difference in the incidence of these organisms in wounds of different ages.

(d) *Anaerobes*. For practical purposes, these organisms can be included with the saprophytes, as they exerted no influence whatsoever on wound healing, and were not responsible for any instances of wound infection in the series of wounds included in this study, with one exception.

In Table I the incidence of the various anaerobes is considerably higher in the younger group of wounds, in which 26 or 24 per cent. contained anaerobes. In fact, 25 of the 26 contained potential gas gangrene organisms. In only one case, a through-and-through wound, in which there was probably an accumulation of serum or blood, did an anaerobe appear to have any pathological effect. The patient developed a low-grade fever, pain and swelling about the wound and when, after six days, the wound was probed a quantity of foul-smelling reddish material was evacuated, and from this *Cl. perfringens* was grown in pure culture. This was not considered a case of gas gangrene, but rather anaerobic growth in an accumulation of inert blood clot.

In the older group of wounds only 27 or 9 per cent. contained anaerobes. Most of these anaerobes were found in complex wounds where débridement had been incomplete, or where there was dead space with accumulated blood clot or serum. In this group of wounds no instance of anaerobic infection was encountered.

In our opinion gas gangrene is related more to the type of wound, to the presence of circulatory interference in the part, to the history preceding primary surgery, and to the primary surgery itself, rather than the organisms present.\*

\* Hamilton, John D., "Anaerobic Infection in War Wounds," *Journal of the Canadian Medical Services*, 2, 387-407. 1945.

## CHEMOTHERAPY AND ANTIBIOTIC THERAPY

It was impossible to assess the effect of oral sulfanilamide on the bacterial flora of wounds as every patient received at least a few tablets before reaching the field dressing station. From the variety of organisms, as well as the incidence of the pathogenic organisms cultured from young wounds (Table I), it is apparent that oral sulfanilamide had little or no effect on the flora of open wounds. This has been reported by others.

Penicillin was used in the first part of 1944 on selected cases, as it was only available in limited quantities. During this period penicillin was administered at the forward surgical centre to severely wounded patients suffering from multiple wounds, compound fractures, or large soft tissue wounds. Dosage was 15,000 units intramuscularly every three hours until a total dosage of 500,000 to 1,000,000 units had been given, or until the patient was evacuated to the base. At the base hospital, where the patient arrived anywhere from 4 to 20 days after wounding, penicillin therapy was not resumed until after examination of the wounds and further surgical treatment.

From Table IV it can be seen that penicillin therapy did not significantly reduce the incidence of *Staphylococcus pyogenes* in the wounds examined. There are several possible reasons for this failure. The dosage of penicillin may have been inadequate. The wounds may have become contaminated after cessation of therapy, due to hospital cross-infection, and some of the strains might have been penicillin resistant. A comparison of those wounds covered by plaster of Paris casts with those covered by bandages only is given in Table V.

It is readily seen that the different types of bandage had no appreciable effect on the incidence of *Staphylococcus pyogenes*. Table V shows a difference

TABLE IV.—INCIDENCE OF PATHOGENS IN PENICILLIN-TREATED CASES AND CONTROLS

	No.	<i>Staphylococcus pyogenes</i>		<i>Streptococcus hæmolyticus</i>		Clostridia	
		No.	Per cent.	No.	Per cent.	No.	Per cent.
*Penicillin-treated cases ...	245	81	33	10	4	48	20
Sulfonamide-treated cases (controls) ...	258	96	37	18	7	21	8

\* Average total dosage 440,000 units per case.

TABLE V.—RELATIONSHIP OF TYPE OF DRESSING TO INCIDENCE OF *Staphylococcus pyogenes*

Type of dressing		Total number of cases	<i>Staphylococcus pyogenes</i> present	
			No.	Per cent.
Plaster of Paris	Penicillin cases	77	17	22
	Sulfonamide cases	47	18	38
Bandage	Penicillin cases	53	13	24
	Sulfonamide cases	170	53	31

in the incidence of *Staphylococcus pyogenes* between the penicillin- and sulfonamide-treated groups. This difference of 10 per cent. in the incidence is not very significant because of the size of the groups. The reason for the lower incidence of *Staphylococcus pyogenes* in the penicillin-treated cases (Table V) lies in the fact that the age of the wounds included is 2 to 8 days only, whereas in the findings shown in Table IV there is included a large group of 115 cases in which the wounds were over 9 days of age.

The incidence of *Staphylococcus pyogenes* was shown in Table II to be closely related to the age of the wound. The same increasing incidence is evident among the penicillin-treated cases. It is possible that the increasing incidence of staphylococcus in these cases is due to contamination added after cessation of therapy. On the other hand, the bacteriostatic action of penicillin may explain the findings, in that growth of organisms was suppressed during penicillin therapy and for a variable period of time following cessation of such therapy, but the organisms multiplied and spread eventually throughout the wound. In support of the latter hypothesis was the discovery of a greatly increased incidence of resistant strains of staphylococcus among the penicillin-treated cases. While, today, many have shown an increase in incidence of penicillin-resistant strains of staphylococci in the hospital environment (60 to 90 per cent.), this was probably not the case at the time of this study (1944) when penicillin therapy was used infrequently.

TABLE VI.—INCIDENCE OF STRAINS OF *Staphylococcus pyogenes* RESISTANT TO PENICILLIN

	Total number of strains	Number of sensitive strains	Resistant strains	
			Number	Per cent.
Penicillin group    ...    ...    ...	69	35	34	49
Sulfonamide group    ...    ...    ...	94	78	16	17

The incidence of 17 per cent. resistant strains of *Staphylococcus pyogenes* in control cases and 49 per cent. among penicillin-treated cases has great significance, and can only be due to the development of resistance to penicillin because of the methods and duration of penicillin therapy. Control cases were treated by the same individuals during the same period of time, so that widespread dissemination of resistant strains by one or more healthy carriers is not a possibility.

#### WOUND INFECTION

An attempt was made to correlate clinical appearances of wounds with the bacterial flora. In the following discussion clinical infection means the presence of purulent or sero-purulent exudate on the wound surfaces, with or without cellulitis, as evidenced by œdema, redness and tenderness in the surrounding tissues. Classification of a wound as clinically infected or non-infected was made by the surgeon together with one of the authors.

TABLE VII.—INCIDENCE OF CLINICAL INFECTION ACCORDING TO AGE OF WOUND

Time from primary surgery to examination	Total number of cases	Infected		Not infected	
		Number	Per cent.	Number	Per cent.
Penicillin cases—2-5 days ...	52	7	13	45	87
6-8 days ...	78	19	24	59	76
9-20 days ...	115	54	47	61	53
	245	80	33	165	67
Sulfonamide cases—2-5 days ...	130	15	12	115	88
6-8 days ...	87	23	26	64	74
9-20 days ...	41	20	49	21	51
	258	58	22	200	78

The increasing incidence of clinical infection shown in Table VII corresponds with the increasing incidence of true pathogens and wound pathogens as shown in Table I.

In Table VIII is given the flora of the clinically infected wounds. In this it can be seen that the appearance of clinical infection was due to *Staphylococcus pyogenes* most frequently and almost exclusively in young wounds. In wounds of six days of age and over, however, wound pathogens are responsible for over a third of the cases of clinical infection in the penicillin group and in only 10 per cent. of the control group. A surprising finding was that an appreciable number of wounds which appeared infected contained only those organisms which we considered as saprophytes.

TABLE VIII.—BACTERIAL FLORA FOUND IN CLINICALLY INFECTED WOUNDS

Time from primary surgery to examination	Total number infected wounds	<i>Staphylococcus pyogenes</i> present		<i>Streptococcus hæmolyticus</i> present		<i>Staphylococcus pyogenes</i> absent			
						Wound pathogens only		Saprophytes only	
		No.	%	No.	%	No.	%	No.	%
Penicillin cases :									
2-5 days ...	7	6	86					1	14
6-8 days ...	19	7	37			11	58	1	5
9-20 days ...	54	30	56	1	2	19	35	4	7
	80	43	54	1	1	30	38	6	7
Sulfonamide cases :									
2-5 days ...	15	10	67					5	33
6-8 days ...	23	16	70	1	4	3	13	3	13
9-20 days ...	20	12	60			3	15	5	25
	58	38	66	1	2	6	10	13	22

In Table IX a correlation of clinical appearance of the wound with the presence of *Staphylococcus pyogenes* is given. The clinical appearance of the wound does not reflect the presence or absence of *Staphylococcus pyogenes*.

An attempt to determine whether the presence of wound pathogens in cases treated with penicillin and containing *Staphylococcus pyogenes* had any effect on clinical appearance was unsuccessful. The incidence of clinical infection in two small series, one containing *Staphylococcus pyogenes* alone, the other *Staphylococcus pyogenes* and wound pathogens, did not show any statistically significant difference. It was thought that the production of penicillinase by wound pathogens might have enhanced the development of clinical infection due to *Staphylococcus pyogenes* in penicillin-treated cases.

TABLE IX.—CORRELATION OF THE PRESENCE OF *Staphylococcus pyogenes* AND THE CLINICAL APPEARANCE OF WOUNDS

Time from primary surgery to examination	Total number of cases from which <i>Staphylococcus pyogenes</i> isolated	Clean		Infected	
		No.	%	No.	%
Penicillin cases—2-5 days ... ..	10	4	40	6	60
6-8 days ... ..	20	13	65	7	35
9-20 days ... ..	51	21	41	30	59
	81	38	47	43	53
Sulfonamide cases—2-5 days ... ..	36	26	72	10	28
6-8 days ... ..	35	19	54	16	46
9-20 days ... ..	25	13	52	12	48
	96	58	60	38	40

In those few cases where saprophytes only were isolated from clinically infected wounds, the wounds were for the most part older than nine days, and showed slough and what appeared to be sero-purulent exudate. It was felt in the majority of instances that the clinically infected appearance of the wound was due to dead and autolysing tags of tissue which may possibly act as an irritant and cause the production of a thin purulent exudate. Support for the belief that these wounds were not truly infected is found below, where it is recorded that such wounds healed uniformly well following suture.

#### WOUND HEALING

Wound healing was studied principally in two series of wounds. The first series of 300 wounds were for the most part soft tissue wounds, and in all of these a primary débridement of the wound was done in a forward surgical centre and the patient transferred to a base hospital for suture. The usual procedure at the time of delayed primary suture was to excise the edges of the wound down to healthy granulations, or so as to allow good apposition of tissues, and to close. The time interval between wounding and suture varied from 2 to 20 days. The smaller series of 109 wounds were mostly minor soft tissue wounds, and in all of these a primary suture of the wound was done. This meant that closure by suturing was done at the time of primary débridement and within an average time of 15 hours after wounding.



An attempt has been made to correlate the bacterial flora, chemotherapy and rate of healing following suture. It was soon learned that various anatomical features of the wound itself were of prime importance in their influence on wound healing. These features have been called "wound faults." They include dead space, unevacuated blood clot, the retention of a foreign body, or the presence of devitalized tissue where it had not been considered wise to attempt its removal. Wound faults have been classified as "possible" or "definite." Definite wound faults have been attributed to all wounds where they were clinically obvious, even though of minor degree. For example, the presence of a fine rubber drain was considered a definite wound fault, as were all wounds complicated by fractures. Through-and-through wounds which had not been converted into a single wound by opening the missile track were all considered as having "possible wound faults." The latter were classified as such because it was felt that in many the adequacy of the débridement of the track was questionable. Tension in a sutured wound was more easily judged and was classified separately as absent, slight, moderate or marked. Moderate or marked tension only was considered as significant.

### *Chemotherapy*

Chemotherapy consisted of penicillin or sulfonamide. The penicillin (penicillin G. sodium) was given as a course of intramuscular injections of 15,000 units every three hours day and night. No local applications of penicillin were used. An adequate course of penicillin was considered to be one which was continued for at least four days (480,000 units) following the suture of the wound, irrespective of any pre-operative therapy. A course of sulfonamide consisted usually of sulfathiazole and occasionally sulfadiazine, and was given in divided doses totalling 5 grams a day. An adequate course was considered to consist of at least three days' post-operative administration irrespective of any pre-operative use. In a few wounds sulfanilamide powder was also applied at the time of operation.

### *Grades of Healing*

Healing in these wounds has been graded as follows :

(a) *Primary Intention Healing.* Complete healing without any droplets of exudate or moisture at any of the suture points.

(b) *Delayed Primary Healing.* This includes those wounds where there was some moisture or exudate at one or more of the suture points, but which were nevertheless completely dry and healed in 16 days.

(c) *Partial Failure.* Any wound where discharge persisted for longer than 16 days and where there was partial or almost complete failure in healing.

(d) *Complete Failure.* Any wound which broke down completely or almost completely.

The results in the delayed primary healing category can be considered as excellent, even though there is a lack of that degree of perfection which should be the aim of all reparative surgery. For this reason, and where the differentia-

tion into primary and delayed healing served no useful purpose, these two have been grouped together and termed 16-day healing.

Some of the partial failures, particularly in the large wounds with small areas of breakdown, could be considered as good practical results, but it would nevertheless seem illogical to consider them as anything else but partial failures. The period of hospitalization required for healing of these varied from 18 days to more than 50 days. Only one was healed in less than 20 days and the average time was greater than 30. Some required resuture.

It was not possible, because of the need for evacuation of casualties, to collect data on the time required before closure of the wound was accomplished in the complete failures. A few of the smaller ones were closed and epithelialized in 25 to 30 days, but some were still open and discharging at the end of 50 days. Almost all required resuture.

There is no doubt that these failures, partial or complete, represent a serious loss not only in hospital space and cost, but also in manpower where the wounds are minor and uncomplicated. Furthermore, the disability resulting from the scar tissue which inevitably follows prolonged suppuration demands that more attention should be paid to the minor flesh wounds, even though they represent no danger to life or limb.

#### *Delayed Primary Suture of 300 Wounds*

In Table X it can be seen that of the 300 wounds, 136, or 45 per cent., were contaminated by true pathogens (coagulase positive staphylococci and/or hæmolytic streptococci), and that 164, or 55 per cent., were free from these particular bacterial species. The results following suture in these two groups show remarkable differences. In the absence of pathogenic staphylococci or hæmolytic streptococci, 125 (76 per cent.) healed by primary intention and a further 22 (14 per cent.) were completely healed in 16 days, giving a combined 16-day healing rate of 90 per cent. In the presence of true pathogens the

TABLE X.—GENERAL BACTERIOLOGY IN RELATION TO WOUND HEALING

General bacteriology of wounds			Results following suture						Incidence of wound factors	
Bacterial status	No. of wounds	Per-centage of total	16-day healing		Partial failure		Complete failure		All wound faults plus significant tension	Definite wound faults only
			No.	%	No.	%	No.	%		
True pathogens absent	164	55	147	90	10	6	7	4	62%	23%
True pathogens present	136	45	35	26	60	44	41	30	63%	22%
Totals for complete series	300	—	182	61	70	23	48	16	63%	23%

16-day healing rate was reduced to 26 per cent. made up of 13 per cent. primary intention and 13 per cent. delayed primary healing. Differences of this magnitude in a series of this size have very great statistical significance and in this case, unless they have been produced by other factors, they point to the tremendous influence of coagulase positive staphylococci and hæmolytic streptococci in the healing of wounds of this type. That other factors are not active is shown by the equal distribution of wound faults throughout both groups. It is shown later that chemotherapy is also not a factor.

In Table XI the effect of various organisms and combinations of organisms on wound healing is shown. Sterile wounds, and those containing saprophytes only, showed almost perfect healing.

TABLE XI.—THE INFLUENCE OF BACTERIA ON WOUND HEALING

Bacterial status of wounds	No.	Results following suture				Incidence of wound factors	
		16-day healing		Partial or complete failure		All wound faults plus tension	Definite wound faults only
		No.	%	No.	%		
No growth ...	38	38	100			58%	21%
Saprophytes only...	105	101	96	4	4	58%	17%
Wound pathogens only ...	21	8	38	13	72	90%	57%
True pathogens ...	27	15	55	12	45	56%	18%
True pathogens with saprophytes ...	62	17	28	45	72	66%	19%
True pathogens with wound pathogens ...	47	3	6	44	94	64%	28%
Total ...	300	182	61	118	39	63%	22%

In that group of 21 wounds containing *Ps. aeruginosa* and/or *Proteus*, without any true pathogens, only 1 healed by primary intention and 7 by delayed healing, giving a 16-day healing rate of 8 or 38 per cent. only. The incidence of possible wound faults and tension in this group was 90 per cent. and of definite wound faults 57 per cent.

Those wounds containing true pathogens only, 27 in all, showed a primary healing in 11, or 40 per cent., with delayed healing in 4, making a 16-day healing rate of 55 per cent. This is a better rate of healing than in those wounds containing wound pathogens only, but the difference is not statistically significant, except in the primary healing rate, where those wounds with true pathogens showed 40 per cent. healing while those with wound pathogens alone showed only 5 per cent. healing. The improved results in that group with true pathogens only is considered to be due to the efficiency of penicillin in wounds with a low fault incidence, penicillin-sensitive bacteria, and lack of added bacterial complications.

The group of wounds containing true pathogens and saprophytes shows a lower 16-day healing rate (28 per cent.) than the group containing true pathogens alone. Possible explanations are, first, that the incidence of wound faults is

10 per cent. higher in the group with added saprophytes. Penicillin therapy in this latter group was inadequate in some cases, and there is also the possibility that penicillin-resistant saprophytes interfered with penicillin therapy by virtue of penicillinase production. There is a further possibility that organisms not able by themselves to initiate infection might, in association with organisms such as *Staphylococcus pyogenes* or *Streptococcus hæmolyticus*, possess pathogenic properties.

The last group of 47 cases, in which a combination of *Staphylococcus pyogenes* and/or *Streptococcus hæmolyticus* with *Ps. aeruginosa* and/or *Proteus* was found, showed the poorest healing rate of all. This is not explicable on the basis of wound factors, because these were lower in this last group. It is postulated that the poor results are the summation of at least three processes: the ordinary harmful effect of *Pseudomonas* or *Proteus* in a wound, the added true infection with pyogenic cocci, and the interference with penicillin therapy by the penicillinase production of *Proteus* and *Pseudomonas*.

Suggestive evidence was found to the effect that a combination of *Staphylococcus pyogenes* and *Streptococcus hæmolyticus* produced more interference with healing than the presence of *Staphylococcus pyogenes* alone. Evidence for this is presented in Table XII.

TABLE XII

Bacterial status of wounds	No. of wounds	Results following suture				Incidence of wound factors	
		16-day healing		Failure		All wound faults plus tension	Definite wound faults only
		No.	%	No.	%		
<i>Streptococcus hæmolyticus</i>	2	—	—	2		100%	100%
<i>Staphylococcus pyogenes</i> ...	109	33	31	76	69	61%	21%
<i>Streptococcus hæmolyticus</i> + <i>Staphylococcus pyogenes</i>	25	2	8	23	92	64%	12%

No conclusions can be drawn from the two wounds containing *Streptococcus hæmolyticus* alone. In the latter two groups, however, the differences between wounds containing a combination of true pathogens and those containing staphylococci alone are significant, as chemotherapy and wound faults were approximately equal in the two groups.

In this series of wounds the anaerobes behaved as saprophytes in so far as their effect on wound healing was concerned. As stated earlier, 41 strains were found in 27 wounds. Multiple strains were found in a few wounds, and it is of interest that these showed definite faults. Adequacy of débridement, in our opinion, is the most important factor in determining the persistence of anaerobes in a wound. In the wounds of this investigation all anaerobes appeared to be innocuous, in that no infection could be attributed to them, nor did they appear to affect wound healing.

## WOUND FACTORS

(a) *Tension.* Failure of a wound to heal successfully following suture is commonly attributed to tension. In this series of cases the data fail to confirm this.

TABLE XIII.—INFLUENCE OF TISSUE TENSION ON WOUND HEALING

Tension		Number of wounds	16-day healing		Failures	
			Number	Per cent.	Number	Per cent.
True pathogens absent	Slight	140	128	91	12	9
	Marked	24	19	80	5	20
True pathogens present	Slight	102	26	25	76	75
	Marked	34	9	26	25	74

In Table XIII it is apparent that even with marked tension present, but no pathogens, a high rate of healing was obtained, whereas in the presence of pathogens and slight or absent tension, healing was reduced to 25 per cent.

(b) *Age.* Age of the wound *per se* had no effect on wound healing, as shown in Table XIV. Again, reduced rates of healing were attributable to true pathogens in the wound.

TABLE XIV.—INFLUENCE OF AGE ON WOUND HEALING

Age		Number of wounds	16-day healing		Failures	
			Number	Per cent.	Number	Per cent.
True pathogens absent	Under 10 days	151	137	91	14	9
	10-19 days	11	8	73	3	27
True pathogens present	Under 10 days	96	26	28	70	72
	10-19 days	30	5	16	25	84

(c) *Size and Site.*—Size of the wound alone had no appreciable effect on wound healing. In the absence of pathogens in the wound 88 per cent. of 51 wounds less than 2 inches long healed by primary intention, and 84 per cent. of 25 wounds from 4 to 6 inches long healed similarly. When pathogens were found in the wound, however, healing rates dropped to 39 per cent. in the wounds under 2 inches long, and 15 per cent. in those 4 to 6 inches long.

Site of the wound appeared important in one location only, the buttock. In 25 wounds of this region, only 9 (or 36 per cent.) healed in 16 days, whereas the 16-day healing rate for all 300 wounds of the series was 61 per cent.

(d) *Wound Faults.* This term was defined earlier and definite faults were attributed to all wounds where there was any question of the presence of dead

space, unevacuated blood clot, or devitalized tissue, as well as where there was a fracture, foreign body or a rubber drain.

In Table XV it can be seen that wound faults alone, in the absence of pathogenic bacteria, did not have an appreciable effect on wound healing. There

TABLE XV.—THE INFLUENCE OF WOUND FAULTS AND BACTERIAL FLORA ON HEALING

Type of fault		No. of wounds	Results following suture								Incidence of wound pathogens	
			Primary intention healing			Delayed primary healing		Partial failure		Complete failure		
			No.	%		No.	%	No.	%	No.		%
No growth	None ...	19	18	95	1	5					—	
	Possible ...	11	10	91	1	9					—	
	Definite ...	8	8	100							—	
True pathogens absent	None ...	57	47	82	7	12	2	4	1	2	7%	
	Possible ...	39	29	74	7	18	3	8			13%	
	Definite ...	30	13	43	6	20	5	17	6	20	40%	
True pathogens present	None ...	64	10	16	7	11	27	42	20	31	31%	
	Possible ...	42	7	17	10	24	17	40	8	19	33%	
	Definite ...	30	1	3			16	54	13	43	43%	

is, however, a striking difference when wound pathogens are present. In the presence of definite wound faults and wound pathogens the 16-day healing rate fell to 63 per cent., whereas in those groups containing no wound pathogens but various degrees of wound fault, the rate of 16-day healing was over 90 per cent. The addition of true pathogens to those wounds with definite faults further reduces healing to 3 per cent. This striking reduction was probably due to the combination of wound faults and pathogenic bacteria, which are not affected by chemotherapy in the presence of this combination of factors.

(e) *Chemotherapy in Relation to Healing.* In this series of 300 wounds closed by delayed primary suture, the effect of chemotherapy was disappointing.

TABLE XVI.—GROSS RESULTS AND CHEMOTHERAPY

Type of chemotherapy	No. of wounds	Results following suture					
		16-day healing		Partial failure		Complete failure	
		No.	%	No.	%	No.	%
Parenteral penicillin ...	92	50	54	28	31	14	15
Oral sulfonamides ...	151	97	64	33	22	21	14
Parenteral penicillin and sulfonamide	32	25	78	5	16	2	6
No chemotherapy ...	25	10	40	4	16	11	44

Reasons for this are not readily apparent but may be related to inadequate dosage, the presence of resistant strains, and failure to use penicillin in the type of case suitable for its use. Results are given in Table XVI.

### Primary Suture of 109 Wounds

The complete bacterial flora of this series is given in Table I. It differs from that of the series of 300 older wounds only in the reduced incidence of true and wound pathogens and in the increased incidence of anaerobes.

All of these wounds were closed immediately following primary débridement at a forward surgical centre. The results are given in Table XVII. The

TABLE XVII.—GENERAL BACTERIOLOGY IN RELATION TO WOUND HEALING IN 109 WOUNDS FOLLOWING PRIMARY SUTURE

Bacterial status of wounds	No. of wounds	Per-centage of total	Results following suture						Incidence of wound pathogens		Incidence of definite wound faults	
			16-day healing		Partial failure		Complete failure					
			No.	%	No.	%	No.	%	No.	%	No.	%
True pathogens absent	79	72	64	81	10	13	5	6	1	1	12	15
True pathogens present	30	28	13	43	9	30	8	27	2	7	4	13
Complete series	109	—	77	71	19	17	13	12	3	3	16	15

over-all healing rate of 71 per cent. is 10 per cent. better than that in the series of 300 wounds closed by delayed primary suture. This is not related to the use of chemotherapy, because such therapy was used similarly in both cases and, as stated below, the information obtained as to the merits of such therapy was inconclusive. The better results with primary suture were related most likely to the lower incidences of *Staphylococcus pyogenes*, *Streptococcus hæmolyticus*, *Ps. aeruginosa* and *Proteus*. True pathogens were found in 45 per cent. of the older wounds and only in 28 per cent. of these younger ones. The incidences of wound pathogens in the two series was 23 per cent. and 3 per cent. respectively. Wound faults became of less importance in the absence of these organisms. As discussed below, however, débridement must be done more widely and more thoroughly in wounds which are to be treated by primary suture.

### DISCUSSION

In the group of wounds herein reviewed, the bacterial flora was similar to that described by other investigators. A possible exception was the low incidence of hæmolytic streptococci in relation to pyogenic staphylococci. Whether this low incidence was related to the widespread administration of sulfanilamide

or not cannot be determined. The low initial incidence of pyogenic staphylococci and its steady rise with increasing age of the wound was due undoubtedly to contamination occurring during transport of the patient and during and after primary débridement of the wound.

The importance of two Gram-negative bacteria became increasingly evident as the investigation progressed. It was found that *Ps. aeruginosa* and *Proteus* had the ability to grow and thrive in pooled serum, blood clot, devitalized tissue, and about foreign bodies. In fact, the presence of any of these wound factors, as we have called them, greatly favoured the development of infection with *Ps. aeruginosa* or *Proteus*. In the absence of such factors these two organisms did not appear to persist in wounds. Moreover, in pooled serum, blood clot, or devitalized tissue, these two organisms did not appear to produce any appreciable effects for at least 5 days. Evidence for this was the clean appearance of all wounds which were less than 5 days of age and which contained either of these two bacteria. In wounds more than 5 days of age, and contaminated with *Ps. aeruginosa* or *Proteus*, the evidences of infection were mild, consisting of a thin, watery yellowish exudate and a slight redness only of the wound margins. It is believed that this inflammation and exudate may have resulted from tissue breakdown due to the action of either or both organisms on dead or devitalized tissue or on blood clots. The lag period between contamination with these bacteria and the harmful effects of their growth may be of great importance in surgical treatment. In our opinion, it is possible to suture wounds containing these organisms and obtain primary healing, provided that foreign bodies are absent, that the wound tissues are healthy, and that the wound surfaces are well apposed, without dead space where blood or serum might accumulate to provide a suitable growth medium.

The interference with healing by the true pathogens, *Staphylococcus pyogenes* and *Streptococcus hæmolyticus*, was evident from the beginning of this study, particularly with the staphylococcus, because of its more frequent occurrence in wounds. These were able to infect and interfere with the healing of sutured wounds in the absence of the wound factors discussed above.

The organisms classified as saprophytes appeared to interfere little by themselves with wound healing. The anaerobes recovered from this series of wounds behaved as saprophytes, with one exception. It is considered that the type of wound is of greater importance in the development of anaerobic infection than the mere presence of pathogenic clostridia.

A comparison of the clinical appearance of unsutured, but previously débrided, wounds with their bacterial flora revealed the complete unreliability of clinical appearance as a guide to their bacterial status. Less than two-thirds of these wounds containing pyogenic cocci appeared clinically infected. On the other hand, of the older wounds appearing clinically dirty, saprophytes only were found in at least 5 per cent. and wound pathogens alone in at least 15 per cent. In wounds less than 5 days of age clinically evident infection was always due to pyogenic cocci.

The wound factors discussed earlier, namely, the presence of devitalized



tissue, of a foreign body, or of dead space with a consequent collection of blood or serum, were very important in interfering with the healing of a sutured wound, but only when true pathogens or wound pathogens were also present. Tension alone was not of great importance, nor was the size or site of the wound. The age of the wound *per se* had little influence, except for its relationship to the presence or absence of pathogenic bacteria.

There is inadequate evidence of the value of penicillin therapy in this report. Dosage was low by present-day standards, this being related in part to inadequate supplies. This shortage led to its being used only in selected cases. The basis of selection was of necessity on clinical grounds, and this was inadequate in many instances. It was used frequently in patients with clinically severe wounds, but whose wounds contained neither true pathogens nor wound pathogens. Good results in these cases could not be attributed to penicillin. It was also used frequently in patients whose wounds contained organisms insensitive to its action, *Ps. aeruginosa*, *Proteus*, and penicillin-resistant staphylococci. Here it was without effect. All of these considerations made its evaluation difficult and inadequate.

The administration of penicillin to sterilize open wounds was a total failure. While this may have had some relationship to inadequate dosage, it is more likely that it is impossible to attain and maintain by parenterally-given drug a sufficient concentration of penicillin in all parts of an open wound and its covering bandages to produce more than a mild bacteriostasis. The presence of tags of devitalized tissue or of inert blood clot may have an important bearing on the diffusion of penicillin to all parts of such a wound. A very real and harmful effect of a course of penicillin therapy to cases with open wounds was the development or appearance of penicillin-insensitive *Staphylococcus pyogenes*. The importance of this was soon discovered because the delayed suture of wounds containing resistant staphylococci resulted in complete failure, despite further penicillin therapy.

There are indications, nevertheless, that penicillin is of value. No instances of spreading tissue infections were encountered in this series. Under protection of penicillin therapy many grossly infected wounds were redébrided and sutured with partial or complete success. In many sutured wounds, however, penicillin failed despite the presence of strains of staphylococci shown to be sensitive *in vitro* to its action. This occurred mostly in those wounds with dead space or other defects, and the failure was undoubtedly due to the inability of the penicillin to diffuse into the inert blood clot in sufficient concentration to affect the bacteria contained there. In other instances there was suggestive evidence that penicillinase may have been produced by certain of the Gram-negative bacilli and saprophytes in sufficient concentration to inactivate the penicillin and to prevent it from reaching the environment of the staphylococci. The combined use of penicillin and sulfonamide appeared to give the best results.

There were no great differences in healing rates between the series of wounds closed by delayed primary suture and the series closed by primary suture. However, there were obvious advantages in the primary suture method of

closure. The incidence of wound contamination and of failure due to infection was appreciably lower. The necessary period of hospitalization was much less than in those where closure was delayed, and the number of operative procedures was reduced markedly.

One feature in the group closed by primary suture has not been disclosed in the tables or text. This is the necessity for wide débridement of the wound. In wounds only a few hours old the clinical recognition of the extent of bruising and devitalizing of tissue is particularly difficult. When a wound is left open following débridement, the presence of a few tags of devitalized tissue is of minor importance, even though such tags did appear to enhance the development of clinical infection. When, however, the wound is closed at the time of primary débridement, the presence of devitalized tissue doomed to slough will lead to a breakdown of the wound within a few days or when sloughing occurs. This is not necessarily infection, and it is not preventable by chemotherapy. In the wounds closed by primary suture and which contain pathogenic bacteria, the presence of devitalized tissue, foreign bodies, dead space, pooled serum or blood clot is as important as in the wounds closed by delayed primary suture. In both types of case these wound defects prejudice the chances of primary healing even under the protective influence of antibiotic and chemotherapy.

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# FOOD POISONING DUE TO *CL. WELCHII*

BY

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## INTRODUCTION

THE report of the Medical Research Council for the year 1951-2 records that one of the most recent additions to the list of recognized causative organisms of food-poisoning is a heat-resistant variant of *Cl. welchii*. The present paper describes an outbreak of food-poisoning in an army camp in which there is evidence to presume that *Cl. welchii* was responsible.

In a comprehensive study of clostridial food-poisoning, Hobbs, Smith, Oakley, Warrack and Cruickshank (1953) pointed out that, as early as 1895, Klein isolated *Cl. welchii* from stools obtained in two epidemics of diarrhœa, but that it was not until the last decade that evidence has been forthcoming to incriminate the organism more convincingly as a possible cause of much hitherto "non-specific" food-poisoning. They note, for example, that no adequate cause was found in 36 per cent. of the 2,431 outbreaks of food-poisoning recorded for 1949.

Smither (1953) investigated 90 unselected cases of gastro-enteritis in general practice, and he could isolate no recognized pathogens from 71 of his patients in this series. He was convinced that a heat-resistant staphylococcal enterotoxin was the commonest cause of mild gastro-enteritis, but he stated that no special bacteriological techniques were employed in his investigations and it appears that his specimens were not examined for *Cl. welchii*.

## THE OUTBREAK

1. *Cases*.—Symptoms suggestive of food-poisoning occurred in 48 out of 138 men who lunched in the camp dining-hall on the day of infection and were questioned or examined in the next day or so. Attention was concentrated on 30 patients out of a company of 61 recruits, the most severely affected unit. Of these 30 men several had more than one complaint, though in all cases the symptoms were mild. Thus, 18 had abdominal pains, 15 had diarrhœa, 14 complained of nausea but only 2 had vomited, and 4 had headache. The onset of symptoms varied from six to twelve hours after the suspected meal. All the patients made a rapid recovery and all but two were fit for training on the following day. Several of those who complained of diarrhœa were given codeine on the day of the outbreak. No other drugs were issued.

2. *Source of Infection*.—It was thought that lunch of the preceding day was

responsible, but, unfortunately, all of the remains of that meal had been sent for swill before suspicion was aroused. The menu for lunch had included a choice of soup, roast and creamed potatoes, roast or stewed mutton, beans, peas, gravy, custard and prunes or trifle. All of the cases had lunched at the main dining-hall, which is supplied by its own cookhouse. This had been inspected during the previous week and found to be satisfactory. Immediately following the outbreak, an inspection of the cookhouse and food-handlers involved revealed no frank source of staphylococcal infection. The nature of the symptoms and their delayed onset were not considered quite typical of a staphylococcal form of food-poisoning, though these points did not exclude the possibility. When the bacteriological reports incriminating *Cl. welchii* were received, the stew was then thought to have been the most likely source of infection. The stew had been prepared on the preceding day, allowed to cool overnight and re-heated the next day. Beans and peas had been added during the cooking. These conditions are ideal for the sporulation and multiplication of any clostridia which may have contaminated the food (Hobbs *et al.*, 1953). In an attempt to confirm the presence of *Cl. welchii* in the cookhouse—and in view of the non-availability of a sample of the suspected stew—specimens of cooked food and meat-bench scrapings were taken from the cookhouse and submitted for a bacteriological report. *Cl. welchii* was not isolated from any of these samples. Several days after the outbreak it was attempted to prepare a list of the food which each soldier had eaten on the day preceding the outbreak, but this had to be abandoned as unreliable. Although by far the majority of those affected recalled eating the suspected meat, a few were uncertain and two were sure that they had not eaten the stew. They had, however, eaten the gravy and vegetables which were served with the stew. It was also evident that many others had eaten the stew with impunity. Of those who had symptoms, it appeared that the recruits were slightly more severely affected.

3. *Cl. welchii* in *Fæces of Patients and Cooks*.—Five specimens of fæces from 5 typical cases were sent for bacteriological examination on the day of the outbreak. On the following day rectal swabs were taken from all of the 30 known patients and from the 5 cooks involved. A heat-resistant form of *Cl. welchii* was cultured from all 5 specimens of fæces and from all of the 30 swabs taken from the cases. Four of the 5 swabs from the cooks also yielded heat-resistant *Cl. welchii*. No organisms of *Salmonella* or *Shigella* groups were isolated from any of the specimens or swabs sent. Fifteen days after the outbreak, stools from 20 of these patients and from 2 of the cooks from whom *Cl. welchii* had been isolated were sent for repeat examination. Culture of these stools revealed that only 7 of the 20 patients and 1 of the 2 cooks examined now harboured heat-resistant *Cl. welchii*. Repeat examination of the 7 positive cases on the 26th day after the outbreak showed that heat-resistant *Cl. welchii* was still present in 3 patients. At this time, stools from the 5 cooks were also sent for culture and none yielded the organism. Finally, on the 36th day, stools from the remaining 3 "positive" patients were submitted and it was reported that heat-resistant *Cl. welchii* was isolated from 2 of these.

Four days after the outbreak rectal swabs were taken from 17 personnel of the barracks who dined at other messes and who had no meals at the main dining-hall. Heat-resistant *Cl. welchii* was isolated from none of these "control" swabs. All of the bacteriological work involved in this investigation was done by the Public Health Laboratory, Newcastle-upon-Tyne, and the techniques employed were those in routine use by the laboratory.

#### DISCUSSION

Hobbs *et al.* (1953) stated that ". . . even if the suspected food were not available, a high percentage of stools showing heat-resistant *Cl. welchii* of the same serological type would be a strong indication that the outbreak was in fact due to *Cl. welchii*."

In this outbreak, a heat-resistant form of *Cl. welchii* was isolated from the stools or rectal swabs of all those initially known to have had symptoms of a mild gastro-enteritis. The organism was also obtained from 4 out of 5 cooks who were at risk but had no symptoms. It was not possible to establish the detailed serology of the strain of *Cl. welchii* involved and the need for a control series of swabs was evident. The result of the control experiment agrees with the figures of Cregan and Hayward (1953), who isolated *Cl. welchii* from the healthy small intestine of only 1 in 42 "normal" subjects, while Hobbs and her colleagues found that, of 45 "normals," the organism was isolated from 2.2 per cent. The latter workers also noted that an organism with the same characters as the heat-resistant variant of *Cl. welchii* concerned in their investigations was isolated from the faeces of about 90 per cent. of the persons at risk. Time did not allow of similar investigations being done on the soldiers at risk in this outbreak, but this is a reasonable explanation of the occurrence of *Cl. welchii* in the cooks who had no symptoms. Hobbs *et al.* concluded that the strains involved in this type of food-poisoning were only feebly toxigenic.

The original source of the infection may have been *Cl. welchii* carried in the meat brought to the cookhouse, though the meat came from a central store which supplied the other messes in the barracks and no food-poisoning occurred in these. Many of the control swabs came from the food-handlers employed in these messes and none yielded heat-resistant *Cl. welchii* on culture. It is more probable that the stew became contaminated as a result of faulty hygiene on the part of a normal carrier who had access to the cookhouse.

#### SUMMARY

1. An outbreak of food-poisoning is described in which the symptoms were mild and transient, commencing six to twelve hours after the suspected meal and subsiding within a day in most cases.
2. Evidence that a heat-resistant form of *Cl. welchii* was the causative organism is presented.

TABLE—OCCURRENCE OF HEAT-RESISTANT *Cl. welchii*.

Specimen	Source	Day	Number Examined	Number+for heat-resistant <i>Cl. welchii</i>
Fæces	Patients	1	5	5
Rectal Swabs	Patients	2	30	30
Fæces	Patients (repeat 20)	15	20	7
	Patients (repeat 7)	26	7	3
	Patients (repeat 3)	36	3	2
Rectal Swabs	Cooks at risk without symptoms	2	5	4
Fæces	Cooks (repeat 2)	15	2	1
	Cooks (repeat 5)	26	5	nil
Rectal Swabs	Men not at risk (Controls)	4	17	nil

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## BACILLARY DYSENTERY IN A STATION IN NORTHERN NIGERIA

BY

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THESE observations were made during 1950-1952 in a station in Nigeria, about 400 miles from the coast and some 2,000 feet above sea-level. The dry season, in which no rain falls, lasts from November to April, and the rainy season is from May to October. The incidence of bacillary dysentery is low during the dry season but increases in March and April, to reach its maximum in June, July and August.

The British personnel live either in messes or in married quarters, and their food is cooked and served by Africans. The African troops have no messes as we know them, but the food for all in single quarters is cooked in communal kitchens, whilst married men live with their families in quarters in unit lines, or in the township, and are issued with uncooked rations to take home.

### INCIDENCE

No major outbreak occurred during the three years covered by this report, nor did any month pass in which no cases were reported. Throughout the year sporadic cases were seen, and there were occasional outbreaks in families, in which two or more individuals were afflicted simultaneously.

It was noticeable that whereas the disease in Europeans pursued a typical course, modified only by chemotherapy, in Africans it was usually far less severe. The patients frequently had little or no constitutional disturbances and the diarrhoea was slight. The families of African troops were treated as out-patients in medical centres unless they were sufficiently ill to warrant admission to the civil hospital. Large numbers complained of diarrhoea, and specimens of faeces were examined from all with this complaint before treatment was instituted. When the diarrhoea was slight, one or more doses of medicine, such as *mist. creta sed.*, were administered, and instructions were given for the patients to report the following day. It was a common finding that these women and children did not report again, and after organisms of the genus *Shigella* had been isolated from their faeces it was difficult to obtain a further specimen of stool for clearance as the patients insisted that they were cured. No reason could be adduced for the mildness of the disease in the African population, but no serological investigations were undertaken to ascertain whether there was a widespread incidence of *Shigella* antibodies in the sera of Africans.

All cases treated in the hospital responded well to treatment with sulpha-guanidine or succinyl sulphathiazole, and none was dangerously ill. The

organisms isolated in the laboratory from patients suffering from bacillary dysentery during the years 1950-1952, with the number of cases due to each, are shown in Table I.

TABLE I.—INCIDENCE OF BACILLARY DYSENTERY BY CAUSATIVE ORGANISMS

Causative organism						Number of cases		
						1950	1951	1952
<i>Shigella dysenteriae</i>	1 (Shigæ)	...	...	...	...	—	1	1
"	2 (Schmitzi)	...	...	...	...	1	8	2
"	<i>sonnei</i>	...	...	...	...	1	11	16
"	<i>flexneri</i>	1	...	...	...	1	3	4
"	"	2	...	...	...	1	37	18
"	"	3	...	...	...	—	2	2
"	"	4	...	...	...	—	—	13
"	"	5	...	...	...	—	—	2
"	"	6*	...	...	...	—	7	11
"	<i>boydii</i>	1	...	...	...	—	—	9
"	"	2	...	...	...	—	3	—
"	"	3	...	...	...	—	1	—
Totals						4	73	78

\* All the organisms of this type produced gas in glucose and mannitol

The small number of proved cases in 1950 was due to technical difficulties in the laboratory which are described below, not to a very low incidence of bacillary dysentery. To support the contention that there was a large number of cases from which the causative organism was not isolated is the fact that 487 specimens of fæces showed "bacillary exudate." It is further borne out by the incidence of proved bacillary dysentery in the two succeeding years.

It will be noticed that there was a large number of different organisms causing the disease sporadically throughout the population, affecting both European and African patients. In 1951 *Sh. flexneri*, type 2, was responsible for more than half the cases, but it is interesting to observe that no cases had any obvious connection with any other case, although at the same time there was a family outbreak due to *Sh. sonnei*. The absence of any other outbreaks is particularly surprising in view of the fact that African food-handlers tend to be somewhat haphazard in matters of kitchen hygiene. Although this is carefully controlled in Army kitchens, no control is exercised over the culinary habits of African soldiers' wives living in quarters. The fly population during the dysentery season appears to be adequate to spread the disease. It remains an enigma that during the three years under review the incidence of the disease was entirely sporadic.

#### LABORATORY TECHNIQUE

All specimens of fæces were examined within a very short time of voiding, usually less than one hour. It was not therefore considered necessary to add any preservative to the specimens, which were examined microscopically in saline and iodine emulsions. In order to ensure that all cases were subjected to



bacteriological examination, any specimen of faeces showing the presence of mucus or pus cells was cultured, whether or not any clinical suspicion of bacillary dysentery had been aroused. Where culture was carried out on specimens for which microscopy only was requested, a note to this effect was made on the form when the initial result was dispatched.

The media used during the survey were as follows :

- (1) Desoxycholate-citrate agar supplied from the United Kingdom in bottles containing 100 ml. of base, to which were added 5 ml. of each of solutions "A" and "B," received in 25 ml. bottles, immediately before plates were poured. It was found that the pH of the base was 6.3—6.5, and this was raised to 7.3 by the addition of sodium hydroxide solution before solutions "A" and "B" were added.
- (2) Hynes' (1942) modification of Liefson's medium, described by Mackie and McCartney (1948). This medium was made up in batches of 4 litres in the laboratory as required.
- (3) MacConkey's bile salt agar supplied from the United Kingdom in bottles of 100 ml., to which neutral red as indicator was added before plates were poured.
- (4) MacConkey's (1908) bile salt agar as described by Mackie and McCartney (1948) made in the laboratory.

Peptone water, agar "slopes" and peptone water sugar media, either supplied from the United Kingdom or made up in the laboratory, were used for the identification of organisms after primary isolation on one of the media mentioned above.

Whenever possible, mucus was selected from the faeces for inoculation, and a piece was well rubbed in as a primary inoculum on the desoxycholate citrate medium before spreading. Before inoculating the mucus on MacConkey's agar, a piece was thoroughly washed in 2 ml. of isotonic saline in a "bijou" bottle.

All members of the *Shigella* group were identified by biochemical reactions and by slide agglutination, and these findings were confirmed by agglutination to titre in the water bath.

In 1950 all specimens were inoculated on to a plate of the desoxycholate citrate agar supplied from the United Kingdom. Although the reaction of the medium had been corrected, it was found that growth was rather poor, and the figures in Table I show that only four isolations of dysentery bacilli were made. In view of this, the constituents were obtained from the United Kingdom, and in 1951 Hynes' modification of Liefson's medium was made in the laboratory.

For a trial period, all specimens were inoculated on to one plate of this medium and one plate of the ready-made medium supplied from the United Kingdom: 146 specimens were investigated; 5 isolations of *Shigella* were made on both media, 22 on the locally made medium alone, and 2 on the medium from the United Kingdom alone.

In view of these findings, the use of the medium supplied from the United Kingdom was discontinued, and all specimens were inoculated on to one plate

of locally made Hynes' modification of Liefson's medium for the remainder of 1951 and the early part of 1952.

In 1952 it was decided to compare the efficiency of MacConkey's medium with desoxycholate citrate agar for isolating dysentery bacilli. Accordingly, all specimens received during a trial period were inoculated on to one plate each of MacConkey's medium received from the United Kingdom, and one plate of locally made Hynes' modification of Liefson's medium: 74 specimens were investigated, 8 isolations of *Shigella* were made on both media, 10 on desoxycholate citrate agar alone and 1 on MacConkey's medium alone.

In view of the great difference in the number of isolations of *Shigellæ* on the two media, and of the fact that the colonial appearances on MacConkey's medium were not very satisfactory, it was felt that this medium also might have undergone some changes during its long journey from Great Britain. To test this theory, MacConkey's medium was made in the laboratory, and 78 specimens of fæces were inoculated on to one plate each of this medium, MacConkey's medium received from the United Kingdom, and locally made Liefson's medium, the latter being used to continue the previous investigation. Twenty-three specimens were found to contain dysentery bacilli, as shown in Table II. A total of 20 isolations were made from MacConkey's medium prepared locally, and 13 from that sent from the United Kingdom.

TABLE II.—ISOLATION OF 23 SHIGELLÆ FROM 78 SPECIMENS OF FÆCES

	MacConkey's medium made		Liefson's medium
	Locally	In U.K.	
Total number of isolations on each medium ... ..	20	13	17
Number of isolations on one medium only ... ..	3	1	2

It was found that the growth on MacConkey's medium made in the laboratory was more profuse than on that received from the United Kingdom, and that colonial differentiation was considerably better. In view of this, and of the fact that more organisms of the *Shigella* group were isolated on the locally made medium, it was decided to discontinue the use of MacConkey's medium dispatched from Great Britain and to continue the comparison between MacConkey's and Liefson's media made in the laboratory. There were 29 isolations of *Shigellæ*, of which 17 were made on both media, 6 on MacConkey's medium only and 6 on Liefson's medium only. These figures include those mentioned above for the same two media.

#### DISCUSSION

Little appears to have been written about bacillary dysentery in West Africa. Murray Lyon (1944) states that it was a common disease of West African soldiers

serving in the Gambia, and remarks that only one case out of several hundred was due to *Sh. shigæ*. None of his cases was dangerously ill, sulphonamide drugs were used only in the more severe cases, and the majority recovered on treatment with sodium sulphate. Archer (1945) carried out an investigation on the use of bacteriophage for the group identification of *Sh. flexneri* isolated in laboratories of military hospitals in West Africa, and gives figures for the incidence of the various types of *Sh. flexneri* which occurred. In a personal communication he breaks down the figures for the isolation of *Sh. flexneri* in West Africa Command during 1943-4 as shown in Table III. During the same

TABLE III.—INCIDENCE OF *Sh. flexneri* IN WEST AFRICA COMMAND, 1943-4

Colony	Types of <i>Sh. flexneri</i>						Totals
	1	2	3	4	5	6*	
Nigeria ... ..	5	10	5	2†	1	3	26
Gold Coast ... ..	2	7	4	—	3	4	20
Sierra Leone ... ..	7	7	5	4†	23	—	46
Gambia ... ..	2	2	—	—	8	—	12
Totals ... ..	16	26	14	6†	35	7‡	104

\* Designated by Archer as "Flexner VI"; biochemical reactions not stated.

† Identity of two strains (one from Nigeria and one from Sierra Leone) was not completely established.

‡ Some others from the Gold Coast were specifically identified locally.

period Archer (1953, personal communication) records the identification of *Sh. shigæ*, *Sh. sonnei*, *Sh. schmitzi*, the para-schmitz organisms Q771 and Q902, and *Sh. alkalescens*, but does not state in which territories these organisms were isolated. *Sh. boydii* type 1 was isolated from one case in the Gold Coast, and Archer believes this to be the first occasion on which this organism was isolated in West Africa. It will be seen from Table I that all the three types of *Sh. boydii* for which antisera were available have been isolated during the present investigation, though none of them occurred commonly and type 3 occurred only once. Consideration of Archer's findings with those shown in Table I shows that almost all the bacilli which have been isolated from cases of bacillary dysentery elsewhere in the world occur in West Africa. In Nigeria the commonest cause of bacillary dysentery would appear to be *Sh. flexneri* type 2. *Sh. dysenteriae* is obviously not a common pathogen in West Africa, although it appears to be widespread. Martin (1946) describes a small outbreak due to a paraschmitz organism (Q902) and discusses the interesting possibility that these organisms reached the west coast by way of the caravan routes across the Sahara from the Middle East. It may be that all the dysentery bacilli in West Africa originally came from the Middle East, but it should be pointed out that far more intensive investigation in the Middle East resulted in organisms of the Shigella group being described there long before they were isolated in West Africa, and it is impossible to say with certainty where the organisms originated. The fact that the disease is widespread in the sub-continent of India, the Middle East,

and West Africa, where there are large Mohammedan populations, and that in all three areas the same rare types of dysentery bacilli are occasionally isolated, suggests that caravan routes and the pilgrimage to Mecca may play a part in the dissemination of dysentery bacilli. Manson-Bahr (1950) gives reasons for the seasonal incidence of the disease in the tropics, and mentions the occurrence of the Newcastle bacillus in Nigeria, but does not appear to state clearly what its biochemical reactions are. Only the Manchester type, producing acid and gas in glucose and mannitol, was seen in the present investigation.

Bacillary dysentery is a common disease among both European and African populations of the station in which this study was carried out. One is tempted to suggest that there is even more bacillary dysentery than is diagnosed among Africans, owing to the extreme mildness of the disease in a large number of cases.

Although there were numerous sporadic cases, and conditions were generally not unfavourable to the spread of the disease, there was no outbreak involving a larger community than one family. In view of the widespread distribution of the causative organisms, demonstrated by the sporadic cases, and of the large proportion of mild attacks among the African population, it would appear that there is at present a well-balanced relationship between host and parasite. It is possible that if this relationship became disturbed in some way, bacillary dysentery might assume greater importance as a cause of morbidity than it has at present, and the comparatively primitive conditions under which the majority of the African population live would then be conducive to serious outbreaks.

From a technical aspect various points arise: The long journey from England, through which supplies have to pass in the high temperatures of ship holds and railway wagons, appears to cause serious deterioration of ready-made culture media. Although the pH of desoxycholate citrate agar base is lowered, this is not the only change which occurs. If the pH is corrected, the medium is normal in appearance, but is still unsatisfactory in use. It appears desirable that both this medium and MacConkey's should be prepared in the laboratory in which they will be used.

Sachs (1939) experienced some difficulty in obtaining properly washed specimens of mucus from dysenteric faeces. He recommends that mucus shreds should be washed twice in tubes of isotonic saline. The method in use in this laboratory was a single thorough washing in 2 ml. of isotonic saline. This was prepared in bulk and distributed in screw-capped "bijou" bottles in order to prevent loss by evaporation during storage before use. Such treatment provided satisfactory removal of intestinal commensals and non-lactose fermenting colonies could be picked with ease from MacConkey's agar plates.

Provided that both media were made in the laboratory, there appeared to be nothing to choose between the results obtained from plating faeces on MacConkey's agar or on Hynes' modification of Liefson's medium. These results differ from those of Hynes (1942), who states that pathogens are isolated on average twice as often from his modification of Liefson's medium as from MacConkey's medium. However, the use of MacConkey's medium involves

the necessity of washing mucus and is therefore more time-consuming. It is interesting to observe that the use of one plate of each medium gives a greater proportion of positive results than the use of one plate of either medium alone. It may well be that the use of two plates of either medium would be as effective as one plate of each. This theory would repay investigation.

#### SUMMARY

The incidence of bacillary dysentery in a station in Northern Nigeria is described, and the causative organisms are mentioned. The disease is often very mild in the African.

Evidence is given that almost all the organisms capable of causing bacillary dysentery have been isolated in West Africa.

Technical difficulties due to deterioration of culture media imported from the United Kingdom are described, and evidence is given that such media are more satisfactory if prepared locally.

Results from the use of MacConkey's medium and Hynes' modification of Liefson's medium for primary isolation of organisms of the *Shigella* groups are compared.

#### ACKNOWLEDGMENTS

The author is indebted to Brigadier G. T. L. Archer for permission to quote some of his unpublished findings, to Major-General A. Sachs for encouragement and advice, to the medical officers, too numerous to mention individually, without whose co-operation this investigation would not have been possible, and to Sergeant P. G. Curtis, R.A.M.C., for technical assistance. The permission of the Director-General, Army Medical Services, for publication of this paper is gratefully acknowledged.

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AN UNUSUAL INJURY AT THE WRIST JOINT  
(see page 307)



FIG. 1

BEFORE REDUCTION, ANTERO-POSTERIOR

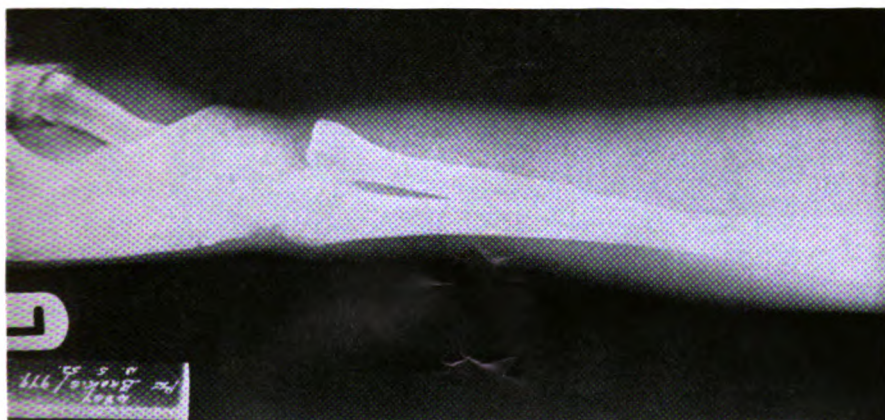


FIG. 2

BEFORE REDUCTION, LATERAL



FIG. 3

BEFORE REDUCTION, OBLIQUE

Face page 306





FIG. 4  
AFTER REDUCTION, ANTERO-POSTERIOR AND LATERAL



FIG. 5  
BEFORE REDUCTION, POSTERIOR ASPECT



FIG. 6  
BEFORE REDUCTION, MEDIAL ASPECT

## REPORT ON AN UNUSUAL INJURY AT THE WRIST JOINT

BY

Major R. P. GOULDEN, M.B., Ch.B.

*Royal Army Medical Corps*

ON 15th May, 1952, a private soldier was vaulting over a "horse" in the gymnasium when he wrenched his left wrist, sustaining a forward dislocation of the head of the ulna and a fracture of the styloid process and adjacent metaphysis of the ulna.

The mechanism of the injury appears to have been as follows: His hands were placed on the end of the "horse" in full pronation, and instead of pushing off with his hands in the normal way his hands remained fixed. The weight of his body was transmitted through the left thigh on to the left forearm, then supinated strongly on the fixed hand, and anterior dislocation of the head of the ulna occurred with detachment of the ulnar styloid and adjacent metaphysis.

Under general anæsthesia—pentothal, nitrous oxide and oxygen—the dislocation was reduced, and the forearm splinted with a Colles' fracture type of P.O.P. cast for five weeks. Union of the fracture had taken place when the plaster was removed on 20th June, 1952.

After seven days' physiotherapy he had regained full painless movement of the wrist.

My thanks are due to Colonel V. C. Verbi, *O.B.E.*, Commanding Officer of this hospital, and Colonel C. M. Marsden, Consulting Orthopædic Surgeon to the Army, who is in charge of this department, for permission to publish this case.



# THE ORALLY ADMINISTERED ANTIBIOTICS IN THE TREATMENT OF NON-SPECIFIC URETHRITIS.— II. AUREOMYCIN (CHLORTETRACYCLINE)

BY

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THE small-scale reports so far published of the results obtained by aureomycin in the treatment of non-specific urethritis have not been discouraging. Thus, Finland *et al.* (1949) successfully treated two cases with this drug. Likewise of four patients treated by Findlay and Willcox (1949), three responded, and Harkness (1949) also claimed seven cures out of ten patients treated. Similarly McVay *et al.* (1951) reported successful outcomes in eleven other cases.

As part of a comparative study of different drugs in the treatment of this condition undertaken at St. Mary's Hospital, Paddington, and King Edward VII Hospital, Windsor, 62 male patients with non-specific urethritis were treated with aureomycin with 16 failures within three post-treatment months, an overall success rate of 74.2 per cent. There were also 9 re-treatments with the same drug. In one patient the urethritis was complicated by epididymitis, and in another by a mild episode of Reiter's syndrome with keratosis blennorrhagica of the penis.

## BASIC DETAILS

Thirty-three of the patients were treated at St. Mary's and 29 at Windsor; 32 were married and 30 were single. No previous history of venereal disease was obtained in 29, whereas 33 patients had had 24 attacks of gonorrhœa, 19 of non-specific urethritis and one of syphilis between them.

The Wassermann and Kahn tests were negative in all. The gonococcal complement fixation test was performed on 51 patients and was negative in 50. The age distribution is shown in Table I.

TABLE I.—AGE DISTRIBUTION OF AUREOMYCIN-TREATED CASES

<i>Years</i>							<i>Patients</i>
21-25	...	...	...	...	...	...	17
26-30	...	...	...	...	...	...	21
31-35	...	...	...	...	...	...	9
36-40	...	...	...	...	...	...	5
41-45	...	...	...	...	...	...	6
46-50	...	...	...	...	...	...	1
51-55	...	...	...	...	...	...	—
56-60	...	...	...	...	...	...	1
61-65	...	...	...	...	...	...	2
							<hr/> 62

The doses of aureomycin given were 4 g. or less in 14 (of which there were 3 of 2 g., 2 of 2.5 g., 2 of 3 gr., 1 of 3.5 g. and 6 of 4 gr.); 5-6 g. was given to

45 patients (of whom 34 received 5 g.) and over 6 g. was given to 3 (of whom 2 received 7 g. and 1 had 8 g.). The failures are related to dosage in Table II.

TABLE II.—AUREOMYCIN-TREATED SERIES: FAILURES RELATED TO DOSAGE

			<i>Cases</i>	<i>Fail</i>	<i>Doses given to failures</i>	<i>Percentage</i>
4 g. or less	...	...	14	4	(1 × 2 g.; 2 × 2.5 g.; 1 × 2 g.)	28.6
5 g. or more	...	...	48	12	(10 × 5 g.; 2 × 6 g.)	25.0

Previous treatment, in the form of one or more antibiotics and/or the sulphonamides, had been given to 30 patients. Fifteen had had one treatment, 11 had had two, 3 had had three, and 1 had had four treatments. The results are related to previous therapy in Table III.

TABLE III.—FAILURES TO AUREOMYCIN RELATED TO PREVIOUS TREATMENT

			<i>Cases</i>	<i>Fail within 3 months</i>	<i>Percentage</i>
Previously treated	...	...	29	10	34.5
Not previously treated	...	...	33	6	18.2
			62	16	25.8

Nine of the failures were re-treated with aureomycin. Six received 5 g., and one each received 7 g., 10 g. and 11 g., respectively. Of these nine cases there were five subsequent failures within three post-treatment months (55.5 per cent.).

In Table IV the failures are related to the drugs previously given.

TABLE IV.—FAILURES TO AUREOMYCIN RELATED TO DRUGS PREVIOUSLY GIVEN  
(Some cases had several drugs)

			<i>Cases</i>	<i>Fail</i>	<i>Percentage</i>
Sulphonamides	...	...	16	5	31.2
Penicillin	...	...	14	8	57.1
Streptomycin	...	...	14	5	35.7
Chloramphenicol	...	...	3	3	100
Terramycin	...	...	3	2	66.6
Aureomycin re-treatment	...	...	9	5	55.5

It is noted that the patients previously treated with the oral antibiotics responded less well than those receiving streptomycin or sulphonamides.

Tables V and VI (page 310) give details of the follow-up and the results of those previously treated and those previously untreated.

#### COMPLICATED CASES

The keratosis of the penis of the patient with mild Reiter's syndrome responded satisfactorily to 6 g. of aureomycin without local or other measures. The complicating epididymitis of another patient responded to 6 g. of aureomycin but relapsed after nine days.

Trichomonads were found in one patient who was known to have had them before. They were still visible and motile under the dark field after 5 g. of aureomycin had been given over five days.

TABLE V.—FOLLOW-UP AND RESULTS OF AUREOMYCIN-TREATED CASES

Follow-up	Previously treated (29 cases)			Not previously treated (33 cases)			Total (62 cases)		
	Fol- lowed	Fail	Cumul- ative %	Fol- lowed	Fail	Cumul- ative %	Fol- lowed	Fail	Cumul- ative %
Nil	29	—	—	33	—	—	62	—	—
1-7 days	28	4	14.3	32	1	3.1	60	5	8.3
8-14 days	21	1	19.1	27	3	14.2	48	4	16.6
15-21 days	17	1	25.0	20	1	19.2	37	2	22.0
22-28 days	15	2	38.3	17	1	25.1	32	3	31.4
1-2 months	12	—	38.3	16	—	25.1	28	—	31.4
2-3 months	8	2	63.3	12	—	25.1	20	2	41.4
Over 3 mths.	4	1	—	9	1	—	13	2	—
Cumulative re- treatment rate at 3 months			63.3			25.1			41.4

TABLE VI.—FOLLOW-UP AND RESULTS OF PATIENTS NOT PREVIOUSLY TREATED GIVEN 5-6 g. OF AUREOMYCIN

Follow-up	Followed	Fail	Cumulative Percentage
Nil	25	—	—
1-7 days	25	1	4.0
8-14 days	24	2	12.3
15-21 days	17	1	18.2
22-28 days	14	1	25.3
1-2 months	13	—	25.3
2-3 months	11	—	25.3
Over 3 months	8	1	—

Cumulative failure rate at 3 months = 25.3%

## SUMMARY AND CONCLUSIONS

1. Sixty-two male patients with non-specific urethritis were treated with aureomycin with 16 failures during three post-treatment months.
2. Patients previously untreated fared better than those who had previously been treated.
3. Aureomycin was less effective if chloramphenicol, terramycin or aureomycin had previously been given than when sulphonamides or streptomycin had been used.
4. Aureomycin gave reasonably good results in doses of 5-6 g. in previously untreated cases, and proved superior to sulphonamides, penicillin, streptomycin and chloramphenicol.

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Grateful acknowledgments are expressed to Cyanamid Laboratories (Lederle) Ltd. for so kindly supplying the aureomycin used in this study.

This paper represents part of the report rendered to the British Medical Association at the end of the term of office as Insole Research Scholar, 1951-2.

## SOME THOUGHTS PROVOKED BY A YEAR IN THE UNITED STATES

BY

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FROM August, 1952, to August, 1953, I had the good fortune to be posted, on exchange, to take over the Dermatological Service of the Percy Jones Army Hospital, Battle Creek, Michigan. These remarks are the outcome of my experiences. I should like first to express my deep gratitude to the Commanding Officer of this large American hospital, and all his officers and other ranks, for accepting me as one of their number, and for making my stay exceptionally interesting and enjoyable.

The Percy Jones Army Hospital was of capacity some 1,000 beds, capable of expansion to 1,500. As it was also an orthopædic centre, many of the patients were on convalescent leave following surgical procedures, so that the actual work was less than might be supposed. The Dermatological Department was part of the Medical Service, and under the direction of the Chief, Medical Service. This "direction," however, was administrative, and there was no interference with professional activities. There was no practical limit to the number of beds at my disposal, but in general there were some ten or twelve dermatological cases in the wards at any one time. The majority of the work was in the clinic, and here out-patients were seen from the military installations in the Mid-West Area, and from families living in and around Battle Creek. As the cost of medical treatment in the United States is high, Army dependants tend to settle around the Army hospitals, so that dependant out-patients in my department out-numbered military by something like two to one.

In addition to the main services, there were naturally adequate ancillary services, and it was practical to provide a comprehensive training programme for interns. Recognized specialists were available in all fields, and consultants from civil sources visited regularly. There were various weekly staff meetings, and these included a tumour conference, medical and surgical service conferences, an X-ray conference, and an excellent clinico-pathological conference, at which case histories were exhaustively discussed, unrehearsed, by various members of the staff prior to a comprehensive final elucidation by the highly competent pathologist. His study included finely reproduced coloured post-mortem slides and histological demonstrations.

All types of work were carried out at the Percy Jones Army Hospital. Being an orthopædic centre, there were many cases from Korea, and the Physical Medicine Section was effective and well equipped. Superficial and deep X-ray therapy was carried out under the direction of the radiologist. There was also

a large Dental Section, in which specialization was carried out to a degree uncommon in this country. For example, routine examination and diagnosis was done in one room; fillings in another; extractions in a third; there was even a specialist in periodontal disease. All in-patients had routine dental care, and were not permitted to leave hospital without dental clearance. The standard of dental hygiene was consequently high, but, on the other hand, the stay of patients in hospital was often prolonged.

All in-patients, regardless of their disorders, were completely investigated. Routine tests included urine examination, complete blood count, blood serology, chest X-ray and naturally a complete physical check, including a blood pressure examination. This example might well be emulated in British hospitals. Much more is likely to be learned from a blood-pressure estimate, a chest X-ray, and a blood count and serology, than from all the routine soundings with a stethoscope that are performed, often perfunctorily, without other investigation.

Venereology was not a separate speciality. Syphilitic patients came to the dermatologist, and these included cases requiring estimation of positive serologies. These problems were not uncommon, particularly in coloured Americans. To assist in the estimation we had the facilities of the laboratories of the University of Michigan Hospital at Ann Arbor. The *Treponema pallidum* immobilization test could be performed there. Cases of gonorrhœa were treated in the "Dispensary" by the doctor who first made the diagnosis, with laboratory confirmation from the direct smear. Cases of non-specific urethritis were handled by the genito-urinary specialists. This system seemed effective. Venereologists must forgive me if I suggest that modern drugs have made their speciality practically redundant. Venereal disease departments should continue to function, because their administrative arrangements for record and follow-up purposes cannot easily be replaced.

As one might imagine, there were differences between the medical services of the American Army and our own, which are pertinent, particularly in these days when service in the R.A.M.C. is ceasing to attract doctors. Some of these differences might well be examined.

First there is in America a large Medical Service Corps (Non-Medical) which is responsible for almost all administration. The Senior M.S.C. Officer, a Colonel, had his office next to that of the (Medical) Commanding Officer. All equipment is the responsibility of the M.S.C., and doctors and nursing staff are not responsible except indirectly. Doctors are left relatively undisturbed to carry on their medical work. At the same time an effort is made to remove "rank consciousness." Medical Officers are always referred to as "Doctor," and their status is accordingly raised in a community in which the professional man is respected. These points are less trivial than they may seem. Nothing is more irritating to a man interested in the practice of medicine than continual administrative interference.

Furthermore, a specialist is promoted while remaining at his work. To reach the highest rank, as in the R.A.M.C., one must turn to administration.

At the same time any competent specialist can reach the rank of colonel and continue his job. Here is another elementary principle. These men are trained to compete with their civilian counterparts. Few competent physicians or surgeons will wish to sacrifice their experience and skill and exchange their vital functions for those of officials willingly. Either permit your specialist promotion within his field, or lose him.

Doctors and M.S.C. officers in America have adequate secretarial aid. Admittedly there is money to spend. But it is obvious to anyone that if there is a complicated administrative system, it will not be run efficiently by untrained National Service boys attempting to type on antiquated typewriters with one finger. One trained permanent secretary at a permanent installation such as any one of the larger military hospitals in the U.K. could do the work of three or four untrained N.S. boys twice as efficiently. I add the proviso that she (or he) should be supplied with some modern equipment : typewriters, filing cabinets, secretarial desks, and good lighting. Many potential fighting men would be released thereby. It is a false economy to "make do" with ineffective material.

In the ways I have described the doctor and the specialist is left free to run a medical practice in the Army. The American Army specialist is well trained. He is of equivalent status to his civilian counterpart, and his training has been precisely similar. For example, a dermatologist has had a three-year course at a recognized teaching centre, and is in possession of the American equivalent of a higher degree. I emphasize again that status is of importance if you wish to attract good men into the Corps.

I would not have my reader suppose that in my view everything in the American garden (or should I say "yard" ?) is lovely. But they are ahead of us in the ways I have enumerated. Rather curiously, the American service doctor is "under-paid" compared with his potential earnings in civil life. Add to this the fact that the "draft" for doctors is (at present) more rigorous than for other classes of the population, and the fact that the "Regular" is seldom permitted to retire, and it will be appreciated that there is much dissatisfaction. Also, I have said nothing about the "American way of life," of which we hear so much. It is not my intention to criticize the American for his way. I would, however, like to say that we in England too have a way of life, and there is much to be said in its favour.

There were many unimportant aspects of American Army hospital life that were strange to me, the visiting Englishman. I was never able to comprehend, nor could anyone inform me, why it was that, winter and summer, all windows were half covered with blinds to exclude the sun and the light, while all the artificial lighting blazed. I made occasional attempts to let in the light and the air, but soon had to desist. My American friends pulled my leg about it. I was the mad Englishman who enjoyed fresh air and playing games and walking for pleasure. It was also a little disconcerting to meet a Hollywood starlet or two, with very little on, on a hospital corridor ; or to find Edgar Bergen and Charlie McCarthy outside the hospital theatre.

My sergeant was an excellent and intelligent fellow of Norwegian extraction

who had, characteristically, very little education. He drove to work in a new "Plymouth," and was very patronizing about my antiquated 1946 model (which I thought wonderful). "Why don't you stay with us, sir?" he would ask me. "You'd make a million!" And in the next breath, "How lucky you are with your Queen, and not having to have elections and things!"

God bless all you wonderful American people who made our visit so varied and entertaining, and memorable! And hi, England! It's mighty fine to get home!

I am indebted to Colonel A. N. B. Odbert, *O.B.E.*, O.C. Cambridge Military Hospital, and to Colonel P. F. Palmer, *O.B.E.*, A.D.M.S., Aldershot District, for permission to publish.

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## ANNOUNCEMENT

THE 61st Annual Convention of the Association of Military Surgeons of the United States will be held from 29th November to 1st December, 1954, at the Hotel Statler, Washington, D.C.

The programme will cover a wide range of professional and scientific subjects, which will include the area of surgery of trauma, preventive medicine, chronic disease and preventive psychiatry. On display at the meeting will be exhibits of the latest advances in the military medical sciences.

For the entertainment of the members and guests, a full schedule of events is being arranged. As in the past, one of the outstanding features is the Honours Night Dinner, on 1st December, at which the Sir Henry Wellcome Medal and Prize, the Gorgas Medal, the Titt Award, the Louis Livingston Seaman Prize, and the Founder's Medal will be awarded.

The Association extends a most cordial invitation to medical and scientific personnel to be present at the convention.

# SALMONELLA SPECIES ISOLATED IN THE MIDDLE EAST

BY

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and

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IN the course of routine work at the Army Central Medical Laboratory, Fayid, in the Suez Canal Zone of Egypt, a number of *Salmonellæ*, other than those causing typhoid and paratyphoid fevers, have been isolated and identified. The *Salmonellæ* are all of human origin and were isolated during the years 1950 and 1951. The routine work referred to includes the examination of specimens from cases of gastro-enteritis and diarrhoea, the examination of British and Egyptian cooks for carriage of enteric organisms, and the clearance of patients convalescent from enteric fever.

This report enumerates the *Salmonellæ* which have been isolated and describes the clinical manifestations of the infection together with any bacteriological or serological details that could be ascertained. It also includes several *Salmonellæ* isolated in R.A.F. laboratories and in Army laboratories in other parts of the Middle East and sent to the Central Medical Laboratory for identification.

## METHODS

The techniques used in the isolation and identification of these *Salmonellæ* are all well recognized, and are not described in detail. Specimens of fæces were plated on desoxycholate-citrate agar both directly and after enrichment in Selenite F. Urine specimens were plated either directly on MacConkey's agar or on desoxycholate-citrate agar after enrichment in Selenite F or a fluid MacConkey's medium containing mannite. Pure cultures were obtained on MacConkey's agar before identification.

*Salmonellæ* were identified by their biochemical and agglutination reactions. The sera used in antigenic analysis were supplied by the David Bruce Laboratories. They were not absorbed, but their homologous titre was specified. Many of the strains required several passages through Craigie tubes before the flagellar antigens could be satisfactorily identified. Phase conversion was accomplished by the use of Craigie tubes containing the appropriate antiserum. Specific sera to individual second phase factors were not available in the Middle East, and consequently certain species could not be identified fully. For example, *Salm. newport* and *Salm. kottbus* could not be distinguished. Apart from this, all



types were identified at Fayid. All strains, other than *Salm. typhimurium*, were sent to the Salmonella Reference Laboratory of the Public Health Laboratory Service for final diagnosis or confirmation.

#### THE CASES

The information available on each case is summarized in Table I. Three anaerogenic strains of *Salm. typhimurium* are noted. The organisms isolated from Case 23 and a further case have not been described previously and will be reported in full elsewhere. No further details of these cases are given here.

Sera were examined for both flagellar and somatic agglutinins to the isolated strain from Cases 1, 3, 6, 7, 8, 10, 11, 12, 13, 14, 17 and 20. Only one serum, taken during convalescence, was examined from some cases ; from others 3 or 4 sera were taken during and after the illness. No flagellar agglutinins were present at a dilution of 1 : 20 and no rise in somatic agglutinins could be demonstrated. The infecting organism was isolated from the fæces of all these cases from whom sera were examined.

#### DISCUSSION

A list of the species isolated together with the number of individuals from which each species was grown are shown in Table II. A high proportion of the *Salmonellæ* reported were isolated from people who gave no history suggestive of a recent *Salmonella* infection. Also shown in Table II are the numbers of those without a recent illness and those giving a history of illness, either at the time of isolation of the organism or shortly beforehand.

Although a large number of specimens of stool and of urine from food-handlers have been examined in the laboratory during outbreaks of enteric fever, the number of *Salmonellæ* isolated from these asymptomatic individuals was unexpectedly high. The lack of flagellar agglutinins in these asymptomatic people suggests that the organisms were confined to the intestinal tract.

#### SUMMARY

The *Salmonellæ* other than those causing typhoid and paratyphoid fevers, isolated and identified at the Army Central Medical Laboratory, Middle East, during 1950 and 1951, are enumerated. The clinical manifestations of the infections are briefly described.

#### ACKNOWLEDGMENTS

We acknowledge with gratitude help received from the following :

Dr. Joan Taylor, who has examined all unusual *Salmonella* strains isolated at the Central Medical Laboratory, Fayid.

Lieut.-Colonel M. H. P. Sayers, O.C. David Bruce Laboratories, who has prepared a number of special sera for our use.

Major A. P. Goffe, who initiated the practice of identifying unusual

TABLE I

Case number	Sex, Age Nationality	Location of isolation	Species isolated	Source of culture	Clinical Summary and General Remarks
1	M. 39 yrs. British	Suez Canal Zone	<i>Salmonella</i> <i>zagreb</i> IV, V, XII e, h-1, 2	Fæces	Isolated during examination of food-handlers suspected of association with an outbreak of enteric fever. No illness or history of intestinal disorder.
2	F. 1 yr. 6 mths. British	Suez Canal Zone	<i>Salmonella</i> <i>typhimurium</i> I, IV, V, XII i-1, 2	Fæces	Pyrexial illness of three days' duration accompanied by loose stools containing blood and mucus. Two other members of the family had loose stools during the preceding week.
3	M. 21 yrs. British	Suez Canal Zone	<i>Salmonella</i> <i>typhimurium</i>	Fæces	Organism isolated during examination of food-handlers suspected of association with an outbreak of enteric fever. Mild fever for a few days six months prior to isolation of organism, but no pathogens isolated from twelve urine and twelve stool cultures at that time.
4	M. British	Benghazi	<i>Salmonella</i> <i>typhimurium</i>	Urine	An enteric-like illness characterized by fever, headache, rose spots over the trunk and a tender, palpable spleen. Chloromycetin commenced on 9th day of illness with good response. A total of 50 gms. given. <i>Salm. typhimurium</i> isolated from urine on 17th day of illness and from stools on 43rd day.
5	M. 5 mths. British	Suez Canal Zone	<i>Salmonella</i> <i>typhimurium</i>	Liver, small and large intestine, bone marrow and spleen at P.M.	Two weeks before death infant developed diarrhoea and vomiting which cleared up in a few days. The illness was followed by feeding difficulties due to a refusal to suck, loss of weight and finally, by rapid dehydration, collapse and death. At autopsy, no macroscopic changes were noted, but <i>Salm. typhimurium</i> was isolated from multiple sites.
6	M. 19 yrs. British	Suez Canal Zone	<i>Salmonella</i> <i>typhimurium</i>	Fæces	Isolated during clearance of a convalescent case of paratyphoid A., proven by blood culture.
7	M. 19 yrs. British	Suez Canal Zone	<i>Salmonella</i> <i>typhimurium</i>	Fæces	Isolated during clearance of a convalescent case of typhoid fever, proven by blood culture. Convalescence uneventful and patient asymptomatic at time of isolation.
8	M. 19 yrs. British	Suez Canal Zone	<i>Salmonella</i> <i>typhimurium</i>	Fæces	Isolated during clearance of a convalescent case of mild clinical enteric fever, not proven bacteriologically, but connected with an outbreak of typhoid fever. Convalescence uneventful save for mild fever (100.5° F.) on one day only nine days before isolation of organism.
9	M. 18 yrs. British	Suez Canal Zone	<i>Salmonella</i> <i>typhimurium</i> Anaerogenic strain	Fæces	Isolated twice during a brief febrile illness accompanied by diarrhoea and vomiting.
10	M. 18 yrs. British	Suez Canal Zone	<i>Salmonella</i> <i>typhimurium</i> Anaerogenic strain	Fæces	Short episode of diarrhoea.

TABLE I (continued)

Case number	Sex, Age, Nationality	Location of isolation	Species isolated	Source of culture	Clinical Summary and General Remarks
11	M. 20 yrs. British	Suez Canal Zone	<i>Salmonella typhimurium</i> Anaerogenic strain	Fæces	Abdominal pain, headache, diarrhoea and vomiting lasting a few hours.
12	M. 18 yrs. British	Suez Canal Zone	<i>Salmonella isangi</i> VI, VII d-1, 5	Fæces	Anorexia, headache and abdominal pain lasting three days. No bowel disturbance. Spleen palpable and tender.
13	M. 19 yrs. British	Suez Canal Zone	<i>Salmonella kotbus</i> VI, VIII e, h-1, 5	Fæces	Isolated when testing food-handlers during an enteric outbreak. No recent illness.
14	M. 39 yrs. British	Suez Canal Zone	<i>Salmonella kotbus</i>	Fæces	Isolated when testing food-handlers during an enteric outbreak. No recent illness. Cases 13 and 14 worked together in the same kitchen.
15	F. Adult British	Suez Canal Zone	<i>Salmonella kotbus</i>	Fæces	Gastro-enteritis.
16	M. Adult Egyptian	Suez Canal Zone	<i>Salmonella kotbus</i>	Urine	Isolated during routine examination of native food-handlers.
17	M. Adult British	Suez Canal Zone	<i>Salmonella moribicans</i> VI, VIII r-1, 5	Fæces	Isolated during routine examination of a food-handler. His only recent illness was an attack of abdominal pain and diarrhoea, lasting four days, eight weeks previously.
18	F. 3 yrs. 5mths. British	Suez Canal Zone	<i>Salmonella eastbourne</i> I, IX, XII e, h-1, 5	Fæces	Pyrexia, diarrhoea and vomiting lasting two days.
19	M. Adult Egyptian	Suez Canal Zone	<i>Salmonella eastbourne</i>	Fæces	Isolated when testing food-handlers during an enteric outbreak.
20	M. Adult Egyptian	Suez Canal Zone	<i>Salmonella eastbourne</i>	Fæces	Isolated during routine examination of native food-handlers. No history of gastro-enteritis.
21	F. 7 yrs. British	Suez Canal Zone	<i>Salmonella london</i> III, X, XXVI l, v-1, 6	Fæces	Isolated during investigation of typhoid contacts. No recent illness.
22	M. Adult Mauritian	Benghazi	<i>Salmonella havana</i> I, XIII, XXIII f, g-	Fæces	Short episode of diarrhoea with blood and mucus in the stools. No pyrexia or constitutional disturbance. Sigmoidoscopy showed a hyperæmic sigmoid colon.
23	M. Adult Mauritian	Suez Canal Zone	<i>Salmonella tel-el-kebir</i> XIII, XXIII d-e, f, 2, 11	Urine	Short illness accompanied by fever, headache, abdominal pain and diarrhoea. Organism isolated at this time and repeatedly thereafter during the next five weeks. Examinations then ceased. <i>Schistosoma haematobium</i> ova present in urine.

TABLE II

	Ill Cases		No illness	Total
	Intestinal symptoms predominating	Constitutional symptoms predominating		
<i>Salm. zagreb</i> ... ..	—	—	1	1
„ <i>typhimurium</i> ... ..	4	2	4	10
„ <i>isangi</i> ... ..	—	1	—	1
„ <i>kottbus</i> ... ..	1	—	3	4
„ <i>morhicans</i> ... ..	1	—	—	1
„ <i>eastbourne</i> ... ..	1	—	2	3
„ <i>london</i> ... ..	—	—	1	1
„ <i>havana</i> ... ..	1	—	—	1

Salmonellæ in the Middle East, and has been intimately concerned with much of this work.

The officers and technicians who have been concerned in the isolation and identification of the Salmonellæ reported here. Those particularly concerned are: Capt. P. Chadwick, Capt. D. G. Rushton, Capt. I. O. Stewart, Lieut. J. F. Watkins and Corporal J. Miller.

The medical officers who have supplied us with clinical details of the cases.

## SMOKE-BOMB PNEUMONITIS: DESCRIPTION OF A CASE

BY

**Captain C. M. B. PARE, M.R.C.P.**

*Royal Army Medical Corps*

and

**Captain M. SANDLER, M.B., Ch.B.**

*Royal Army Medical Corps*

THE reaction between hexachlorethane and zinc oxide, with the liberation of particles of zinc chloride, is widely used for the production of smoke-screens by the armed forces. Although no ill effects have been reported in the concentrations usually found, when the smoke is liberated in an enclosed space it may act as a lung irritant. The only case which we have found reported in the literature was when the smoke-screen was laid down by a ship at sea (Whitaker, 1945). A zinc chloride cloud is very caustic when in contact with moist areas of the body, and it is presumed that this is the active agent, although, according to Ardran (1950), other products of combustion of the cannister cannot be excluded as a contributory factor.

### DESCRIPTION OF CASE

E.H., 18 years, admitted to hospital 5th July, 1952. Past history showed that he was quite well until six days before, having had no previous chest trouble or other illnesses he could remember. He had no cough or sputum, no hæmoptysis, he was not short of breath, and his weight was steady and energy good.

Six days before admission he was on an army exercise and was on the top floor of a house when a smoke cannister was set off on the stairs. He could not get out of the house and had no respirator. He was exposed to the smoke for about ten minutes before the cannister and smoke were cleared. As a result of the smoke he coughed a lot, but without producing sputum; his mouth felt very dry and he could not eat. He vomited half an hour later. He was short of breath and felt rather sleepy, so that he slept in the Land Rover which took him to the Medical Reception Station. At the M.R.S. he was given some tablets and slept all night. The following day he was transferred back to his unit, where he was put on light duties.

On the second day he had a free epistaxis lasting a quarter of an hour, and was still short of breath. He was admitted to the Medical Reception Station, where it was noted that his temperature was raised to 99-100° F. Two days later it was noted that he had a pain in his side, and the following day that he had some difficulty in breathing, which later that night became more pronounced. At this time the medical officer first noted adventitious sounds at the base of the

right lung. The patient's temperature was still 99-100° F. He was put on Aq. penicillin, and the following day transferred to hospital.

When admitted he did not look ill. There was no cyanosis or distressed respiration. Temperature was 100° F. and respiration rate 24 per minute. The most pronounced feature on examination was the very poor expansion of his chest, both sides of which, however, moved equally. The mediastinum was central and there was no clubbing of the fingers. There were moist crepitations over all areas of both lungs, and at both bases there was markedly diminished air entry associated with impairment of the percussion note.

In spite of the moist sounds in his chest, which became almost "coarse," he produced no sputum, and great difficulty was found in getting a little clear mucoid sputum for bacteriology by postural drainage.

*X-ray of Chest.*—Patchy consolidation of all areas of both lungs, most pronounced in the mid-zones.

*Blood Count.*—Hb. 106%. (15.8 g./100 ml.)

W.B.C. 7,400. P. 66%, L. 29%. M. 3%, E. 2%.

*Sputum.*—Direct smear showed scanty Gram-positive cocci and Gram-negative cocci. Culture yielded a light growth, mainly *Proteus* and pneumococci.

*Urine.*—Nil abnormal in routine examination, deposit or culture.

The penicillin which had been started prior to admission was continued and, in addition, the patient was put on breathing exercises. His chest expansion improved remarkably, and at the same time air entry increased at the lung bases and loud coarse crepitations could be heard. His temperature, which was irregular in type, rising to a maximum of 100.6° F., gradually fell to normal by the fourth day in hospital.

Throughout this period the patient had no abnormal physical signs apart from those in his chest.

*21st July, 1952, X-ray of Chest.*—There was no evidence of consolidation remaining, only a diffuse fine mottling of all areas of both lungs evenly and symmetrically distributed and almost "miliary" in appearance.

#### *Further Investigations*

Mantoux 1/1,000 : Negative. X-ray of hands : Nil abnormal.

Mantoux 1/100 : Negative.

Plasma Proteins : Albumin 3.7%, globulin 3.1%. Total 6.8%.

Six gastric lavages : Negative for T.B. by direct smear and on culture.

By 1st August he was taking walks in the grounds. His chest had completely cleared clinically, but X-ray still showed a diffuse fine mottling. This, however, had completely cleared by 18th August, when he was discharged from hospital.

Follow-up ten months later showed no change in clinical or radiological picture, which were both normal.

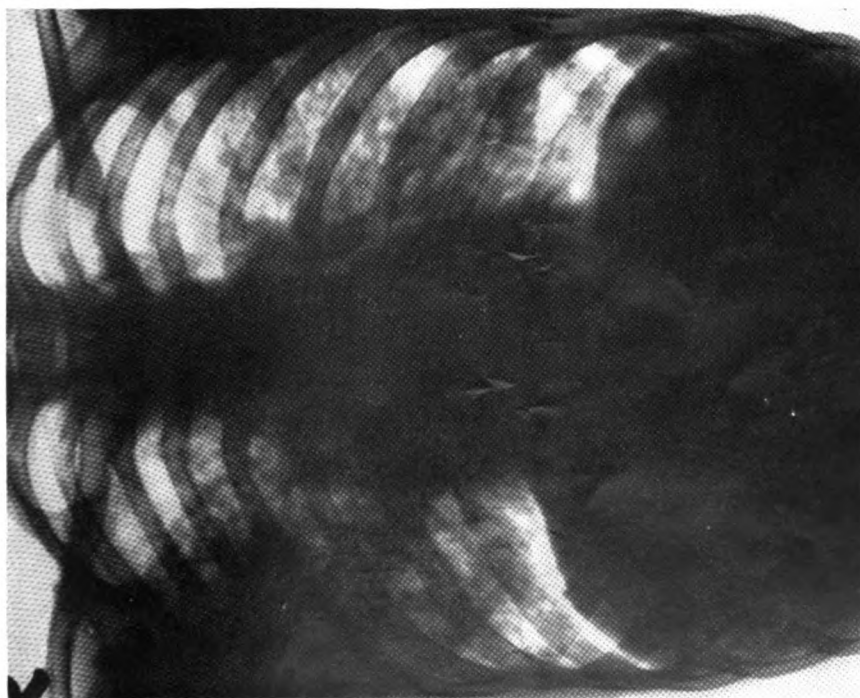
#### DISCUSSION

We were lucky in seeing our patient earlier than in Whitaker's case, and were able to confirm Ardran's (1950) finding in dogs that the general condition

is good despite the gross radiological findings. In contrast to phosgene poisoning, where the radiological signs clear in less than a fortnight (Steel, 1942; Sage, 1944), the mottling persists much longer (Whitaker, 1945; Ardran, 1950), and in our case it was still present four weeks after asphyxiation. Other workers' findings indicate that the initial pulmonary pathology may be due to intense initial broncho-constriction and some œdema. The œdema is not progressive and rapidly resolves, but leaves multiple fine areas of atelectasis with surrounding areas of emphysema, which produce the radiological appearance of mottling. (Schatzki, 1943; Durlacher and Bunting, 1947; Tobias *et al.*, 1949).

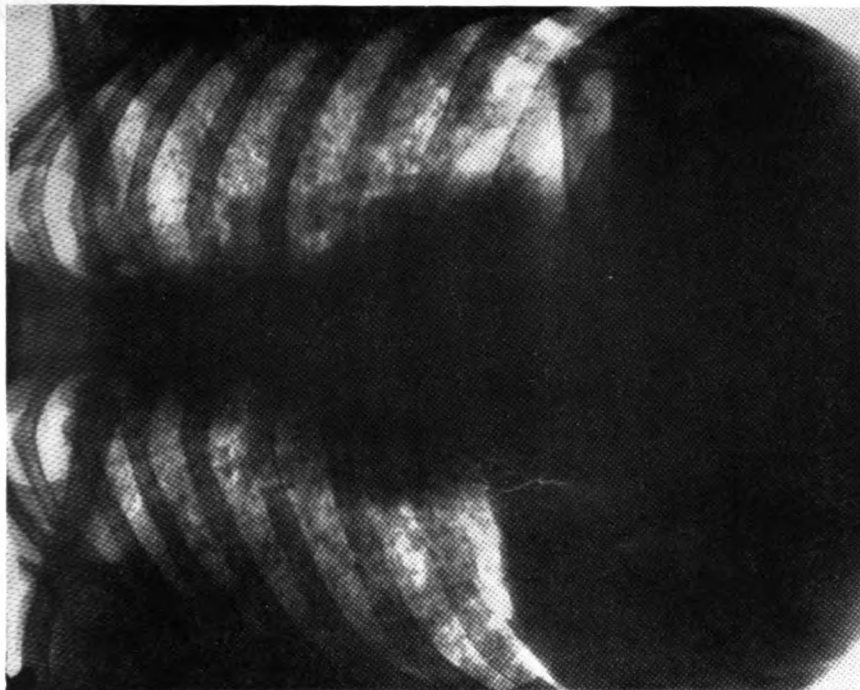
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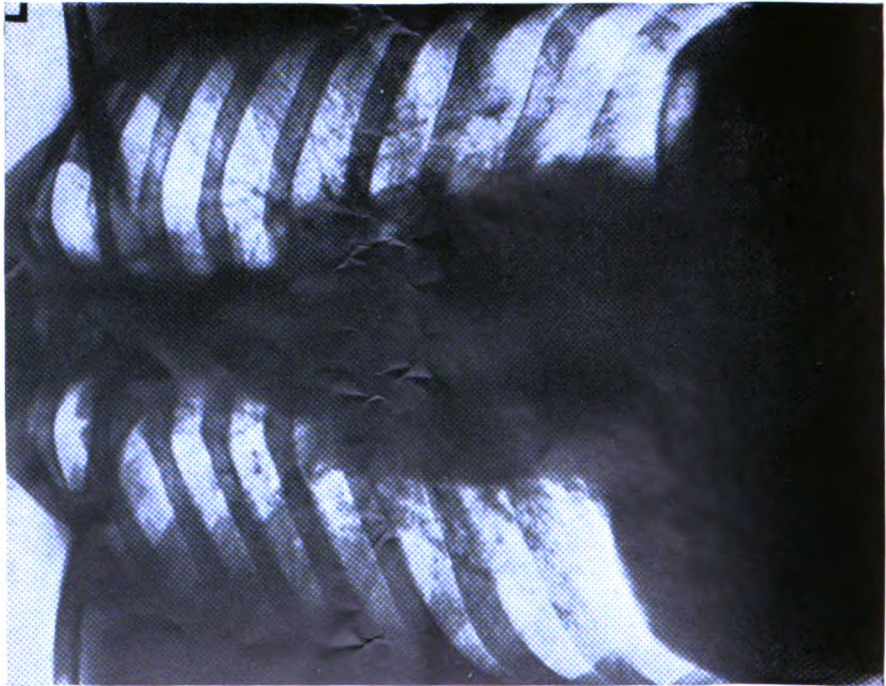
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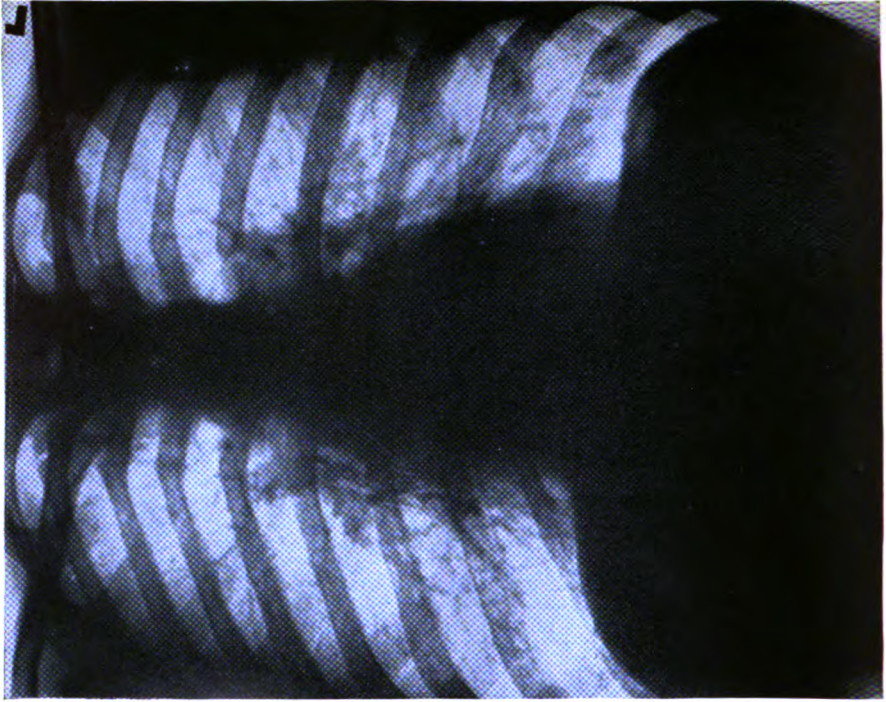


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## *Matters of Interest*

### PAPERS BY R.A.M.C. OFFICERS

Lieut.-Colonel J. Mackay-Dick : Nursing the Tuberculous (letter), *Lancet* (1954), ii, 44-45.

Lieut.-Colonel J. Mackay-Dick and Captain J. B. L. Howell : Significance of Cervical and Mediastinal Lymphoglandular Calcification in Pulmonary Tuberculosis. *Tubercle* (1954), 35, 146-149.

Major-General L. T. Poole : Provoking and Localizing Factors in Poliomyelitis (letter). *Lancet* (1954), i, 1133.

### MAJOR F. E. COLLARD, R.A.M.C. (retd.)

THE *Guernsey Evening Press* for 10th April, 1954, reports that the Rev. F. E. Collard was to resign his assistant curacy of the church of St. Michael du Valle, Guernsey, on 30th June, at the age of 84.

Mr. Collard was born in 1869, joined the Medical Staff Corps in 1889, and retired with the rank of major, R.A.M.C., on 12th September, 1924. He was at Halifax, Nova Scotia, when the last English garrison handed over to Canadian troops, and served in the South African and First World Wars.

After his retirement from the Army, Major Collard had charge of the Anglo-American chaplaincy in Cologne from 1924 to 1935 as a lay-reader, and then until 1938 as deacon and priest. He spent some months at the English church in Vienna, with special charge of the Jewish Christians, and on being required to leave Vienna, returned to Cologne until he was again forced to leave in 1939. From Germany, Mr. Collard went to Guernsey, where he served as assistant curate of St. Michael's from 1939 until his retirement this year, with intervals as priest-in-charge there and at St. Stephen's.

After his brushes with the Germans in Guernsey, Mr. Collard is perhaps fortunate to have reached a second retirement. May it be as full and happy as his twofold career seems to have been !

(The Editor is obliged to his colleague of the *Guernsey Evening Press* for permission to print this summary.)

### THE ROYAL SANITARY INSTITUTE

#### "CLEAN FOOD" COMMITTEE

REFERENCE to the setting-up of a Standing Committee on the Hygiene of Food and Food Equipment is contained in the annual report of the Royal Sanitary Institute, which was approved at the annual general meeting of the R.S.I., held in London on Tuesday, 18th May, when Lord Percy of Newcastle presided over a good attendance of members. In a review of the Institute's activities during the previous twelve months, it was stated that a new policy of staging special exhibitions dealing with various aspects of health education had been an unqualified success. These exhibitions had attracted over 12,000

visitors. Reference was also made to the introduction of a new examination in the inspection of water drainage installations designed to create the highest standard of plumbing.

Considerable development has also taken place in the Institute's library, which, it is claimed, comprises one of the largest collections of works on health in the United Kingdom. New publications recently added cover the health aspects of nuclear fission and the hydrogen bomb.

The "Clean Food Committee," which includes representatives of almost all sections of the food and catering industries, is concerned with raising the standard of food hygiene in the United Kingdom. It has since created six sub-committees covering such widespread aspects of the problem as manufacture, production, and processing; wholesale trade; transport; retail trade; catering; and methods of food hygiene education.

Dr. J. Greenwood Wilson, Medical Officer of Health, Cardiff, and Port Medical Officer-Elect of the City of London, and Professor H. Burrow, Department of Veterinary Medicine, Royal Veterinary College, London, have been elected Chairman and Deputy Chairman respectively of the Standing Committee for the ensuing year.

Each sub-committee will concern itself with storage and equipment as it affects its own particular task.

### ROYAL SANITARY INSTITUTE PRIZE ESSAY COMPETITIONS

A number of prize essay competitions are announced by the Royal Sanitary Institute for which attractive cash prizes will be awarded.

The John Edward Worth Prize (the funds are provided by a legacy left by the late John Edward Worth, a Fellow of the Institute) is to be awarded for the best essay on "The Advantages and Disadvantages in the Use of Alternative Materials as Substitutes for Traditional Materials in Building Construction, Sanitary Appliances and Fittings."

The award, which will take the form of a cash prize of £70, is to be used for the study of domestic sanitary science in Europe.

The John S. Owens Prize (the funds are provided by a legacy left by the late John S. Owens, a Fellow of the Institute) is to be awarded for an essay on "Modern Practices in the Conservation of Heat, with special reference to Smokeless Fuel Appliances." The prize will consist of 20 guineas.

A prize of £21 is also to be awarded for the best essay on "Suggestions for the Training of Health Visitors to meet the Present-Day Conception of the Health Visitors' Work." Health visitors are invited to discuss the advantages and disadvantages to a health department of an all-purpose nurse.

The competitions are open to all, excepting that relating to the John Edward Worth Prize, in which particular case entries are restricted to persons resident in the British Isles.

Full particulars regarding these prize essay competitions, the closing date

for which is 31st December, 1954, can be had from the Secretary, The Royal Sanitary Institute, 90 Buckingham Palace Road, London, S.W.1.

### "THE FORCES MAGAZINE"

(formerly *The Fighting Forces*)

THE *Fighting Forces* magazine reappeared in May, 1954, as a quarterly under the title *The Forces Magazine*. It is under new editorship.

The contents include short, interesting and informative articles on outstanding events of the day ; Service news from all quarters (with special notes from Staff Colleges and Experimental Establishments) ; the Services in Parliament, and news letters from Commonwealth and U.S.A. Forces in Great Britain. Well-written short stories are a speciality.

As more and more women are making the Services a career, there is a woman's section in the magazine, in which are featured articles of particular interest to women. It is intended to publish, in each issue, a practical cooking recipe.

As in the past, *The Forces Magazine* stands for world peace, and, in this connection, fullest publicity is given to the North Atlantic Treaty Organization (N.A.T.O.), whose aims and objects are, it is felt, insufficiently ventilated.

Before 1950, *Fighting Forces* circulated in countries outside Great Britain, notably the United States, France, Yugoslavia, and even in Russia. It is hoped that *The Forces Magazine* will continue this tradition and thus lead, if only in a small way, to a better understanding between the various nations of the world.

It is hoped to make *The Forces Magazine* a magazine in which all ranks, serving or retired, can exchange their views and air their legitimate grievances.

There are many writers in the Services, men and women who have a story to tell, but who have not, for one reason or another, had the opportunity to tell it . . . in print. It is the policy of the magazine to encourage new writers. All submissions will be carefully read, and whilst only those of sufficiently high standard will be accepted, the reasons for rejection will be indicated.

The cost of the magazine will be 2s. 6d. per copy (2s. 9d. post free). Annual subscription will be 10s. (11s. post free).

Lieut.-Colonel R. M. Raynsford, who was Editor of the *Fighting Forces* for twenty-four years, has now retired, and has handed over the Editorship to Wing Commander W. Bateson ; but the new personnel are assured of the previous Editor's wise counsel.

Each number will contain a useful article dealing with promotion and Staff College Examination papers.

### STRESS

DR. HANS SELYE would be grateful if authors of articles on problems pertaining to research upon "stress" and the so-called "adaptive hormones" would send him a reprint. Dr. Selye's address is Université de Montreal, Case Postale 6128, Montreal, Canada.

**"THE NEWS AND GAZETTE"**

THE R.A.M. College Library has only Volumes 14 and 15 of *The News and Gazette* (the forerunner of the present *Army Medical Services Magazine*), and it is desired, if possible, to complete the set. If any officer has any earlier issues, from January, 1921, to December, 1946, which he would be prepared to give to the Library, they would be much appreciated. Even single numbers would be of value. Offers should be made to the Librarian, R.A.M. College, Millbank, London, S.W.1.

**GEORGE KNIGHT CLOWES MEMORIAL PRIZE ESSAY, 1955**

Prizes : First prize £35 ; second prize £15.

Closing date : 7th January, 1955.

Subject : "When, after the war, National Service was instituted as a means of filling the ranks of the Regular Army, many people predicted that it would result in serious loss of fighting efficiency, especially in distant overseas units. These forebodings have proved false, and the Army has fulfilled all its commitments successfully.

"Comment on the present Army system of handling, training and utilizing the National Service man and the improving existing methods. If possible give examples from your own experience, or which are within your knowledge."

*General conditions for the essay are contained in A.C.I. 625/53.*

**AWARD FOR WORK UPON TREPONEMATOSES**

A special international award, to consist of a bronze medal and a scroll, is planned to honour outstanding workers in the field of the venereal diseases and non-venereal treponematoses. Provided sufficient funds can be collected to guarantee an annual award out of interest on a special fund, this award will be administered by the World Health Organization, in a manner similar to W.H.O.'s administration of the Darling Award for outstanding achievements in malaria control.

Since this is to be an international award, funds are being sought from interested persons and organizations throughout the world. Individuals and organizations in the United Kingdom are invited to contribute towards the establishment of this special fund. Cheques should be made payable to "The International Treponematoses Award Fund," and sent to the temporary custodian of funds collected in the United Kingdom: Dr. R. R. Willcox, St. Mary's Hospital, London, W.2.

The temporary custodian of funds collected in the United States is Dr. Frank W. Reynolds, The Saratoga Spa, Saratoga Springs, N.Y.

## *Book Reviews*

**A TREATISE ON HYGIENE AND PUBLIC HEALTH.** By B. N. Ghosh, F.R.F.P. & S. (Glas.), F.R.S.(Edin.). Thirteenth Edition. 1953. Pp. xvi + 787, with 151 illustrations. Calcutta : Scientific Publishing Co. 25s. 6d.

The revision should have been more thorough ; more old material could well have been discarded and much more recent material, such as the International Sanitary Regulations, 1951, included.

One would like to see more dogmatic advice given on such basic points as water purification and the use of insecticides. Also the tabular style of recording information is so much easier for the student to read than the discursive paragraph.

The book rightly concentrates on the environmental side of hygiene ; one hopes that it will continue to do so until hygiene and sanitation are of an evenly high standard throughout India.

Reproduction of many illustrations is poor ; they should be much bigger and comprehensible without reference to the text.

T. C. R. A.

**POLYGLOT MEDICAL QUESTIONNAIRE.** By S. Chalmers Parry, M.A. (Cantab.), M.R.C.S., L.R.C.P., D.P.H. Pp. 62. London : H. K. Lewis. 1953. 12s. 6d.

The object of this compact booklet is to enable a medical history to be taken from a patient who cannot speak the doctor's language, as long as both can speak any of the following twelve languages, viz. : English, Danish, Dutch, French, German, Italian, Norwegian, Polish, Portuguese, Russian, Spanish and Swedish.

It contains a total of 191 simple questions, phrases and individual words, each of which is translated in all the languages mentioned. They are tabulated alphabetically under different sections headed Past Medical History, Family Medical History, Drugs, Diet and Medical Vocabulary.

The questions are so worded that they need merely a Yes or No for an answer. Provided, therefore, that the patient can read, the doctor can elicit a history by producing this book, looking up in his own language the question required, and pointing to its corresponding translation in the patient's language.

This is a useful book for doctors like ship's surgeons, etc., who might not know the language spoken by those for whom they are medically responsible.

T. A. P.

**OFFICIAL HISTORY OF THE CANADIAN MEDICAL SERVICES, 1939-45. Volume II. Clinical Subjects.** By W. R. Feasby, B.A., M.D. Ottawa : The Queen's Printer. Pp. xv + 537, 5 illustrations in colour, 7 photographs (black and white). \$5.00.

A comprehensive review of the clinical and statistical aspects of the work of the Medical Services of all three Canadian armed forces in World War II.

T. C. R. A.

**RATNA HIRURGIJA.** Pp. 1,107 with 274 illustrations. Belgrade : Army Medical Directorate. 1953.

We have received these two volumes of the Yugoslav War Surgery, which are both well produced and well illustrated.

R. J. N.

**MANUAL OF PSYCHOLOGICAL MEDICINE.** By A. F. Tredgold and R. F. Tredgold. Third Edition. Pp. xi+328. London : Baillière, Tindall & Cox. 1953. 25s.

The third edition of this book is under the joint authorship of Dr. A. F. Tredgold and his son, and most of the chapters have been revised by the incorporation of relevant recent advances. There is a valuable section on the war neuroses where the lessons of World War I and the personal experience of Dr. R. F. Tredgold in World War II are combined. The material is essentially clinical and practicable and is written in an easy and discursive style. It is a valuable book for both the student and the general practitioner. Together with his *Text Book of Mental Deficiency*, it constitutes a fitting monument to Dr. A. F. Tredgold's contributions to psychiatry.

J. F. D. M.

**PSYCHOLOGY, THE NURSE AND THE PATIENT.** By Doris M. Odlum. Second Edition. Pp. 168. London : *Nursing Mirror*. 1954. 12s. 6d.

This is a greatly enlarged version of the first edition. There is a concise, but nevertheless comprehensive, account of the psychology of human behaviour, with special emphasis on that of the sick person. The problems of the nurse-patient relationship involved in the many events of the daily nursing round, both major and minor (but none the less important to the patient), are dealt with in an essentially stimulating and practical way. The chapter on the nursing of children should do much to convince even the most diehard "isolationists" that children in hospital should be allowed frequent visits from their parents. This is a book that should be on the table of every Sister Tutor and one that would benefit all nurses to read. Doctors, too, would find much of interest in this excellent publication.

J. F. D. M.

**SURGERY : HISTORY OF THE SECOND WORLD WAR.** Edited by Sir Zachary Cope, B.A., M.D., M.S., F.R.C.S., United Kingdom Medical Series, compiled under the Direction of an Inter-Services Editorial Board. Editor-in-Chief : Sir Arthur S. McNalty, K.C.B., M.D., F.R.C.P., F.R.C.S., who has written the foreword for this volume. Pp. xix+772, 92 plates (several in colour) and 14 figures. London : H.M.S.O. 1953. 80s.

This volume contains a vast amount of information of great interest to members of that great team who were connected with or worked in surgery during 1939-1945. It will be also a valuable source of reference and of inspiration for their successors.

The editor and contributors are to be congratulated on so well selecting their material and for the perspective in which it is presented.

All phases of the surgery of war among civilians and in the varied conditions under which the three Services sustained and succoured their casualties have mention and discussion in the twenty-five chapters of this magnificent work. Each main subject is dealt with by those of wide experience in it, whose names have a rightful place in the History of Surgery in the Second World War.

This book should be available in all medical libraries, including those in Service hospitals. Military surgeons and other Medical Officers will derive information and great pleasure from the useful perusal of its pages.

C. M. M.

**THE ANATOMY AND SURGERY OF HERNIA.** By Leo Zimmerman, M.D., Professor of Surgery and co-Chairman of the Department of Surgery, Chicago Medical School, and Barry J. Anson, Ph.D. (Med. Sc.), Professor of Anatomy, Northwestern University Medical School, Baltimore. Pp. x+374, 204 illustrations. 1953. First Edition. London: Baillière, Tindall & Cox. 76s. 6d.

This publication is a very complete and interesting study of all forms of hernia. The subject-matter is very readable and there are more than two hundred excellent illustrations. The anatomical descriptions are very fully and clearly expressed. Each type of abdominal hernia is considered separately and in great detail. The recommendations for the various available methods of treatment are sound and reliable. I am sure this work will be of considerable value to the experienced surgeon as a book of reference, and sections of it will be very useful to junior surgeons in the Services.

R. A. S.

**ACUTE INFECTIOUS HÆMORRHAGIC FEVERS AND MYCOTOXICÓSES IN THE UNION OF SOVIET SOCIALIST REPUBLICS.** Medical Science Publications 2. Army Medical Service Graduate School, Walter Reed Army Medical Centre, Washington, D.C., May, 1953. Pp. vii+140, 7 figures and 5 maps. 60 cents.

This well-presented pamphlet gives a concise account, with full bibliography, of the various infectious fevers of the U.S.S.R. which have in common the occurrence of a bleeding tendency. Some are known to be caused by viruses, while others are due to certain toxins ingested in food. The most interesting feature is the striking resemblance between nephropathia epidemica, which occurs in Northern Scandinavia, and the so-called acute hæmorrhagic fever of the Far East. In neither is the ætiology known, and it is noteworthy that Coster and Lublin believe the disease (*i.e.*, nephropathia epidemica) is not an independent infectious disease but rather that it is a mode of reaction of certain individuals to some known but unidentified agent or agents, for a similar suggestion has been made in relation to the Far Eastern fever.

K. P. B.



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 Pp. xii+236, 55 illustrations. 1954. London: Churchill. 25s.

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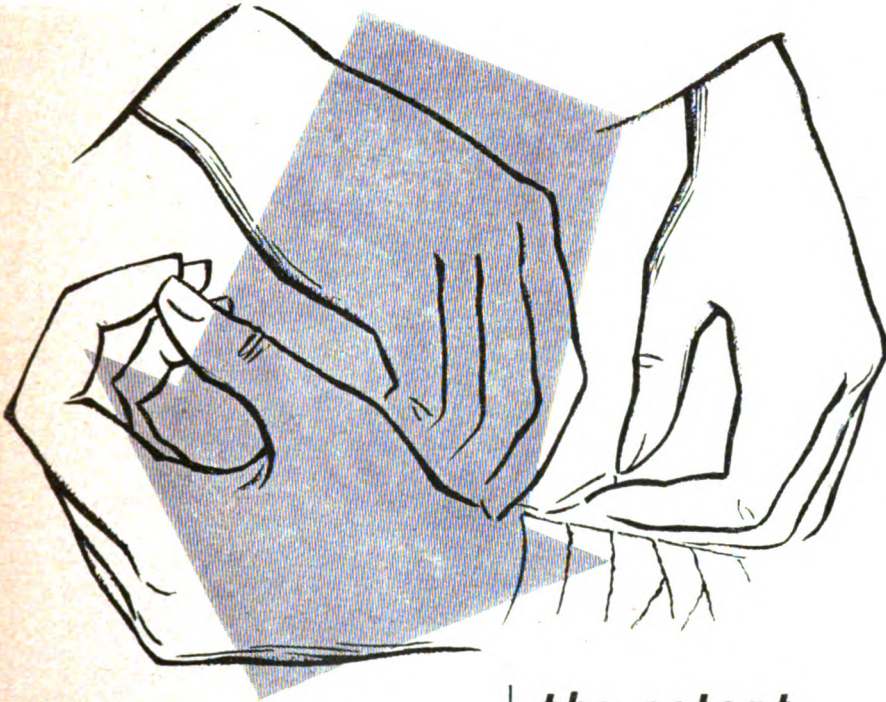
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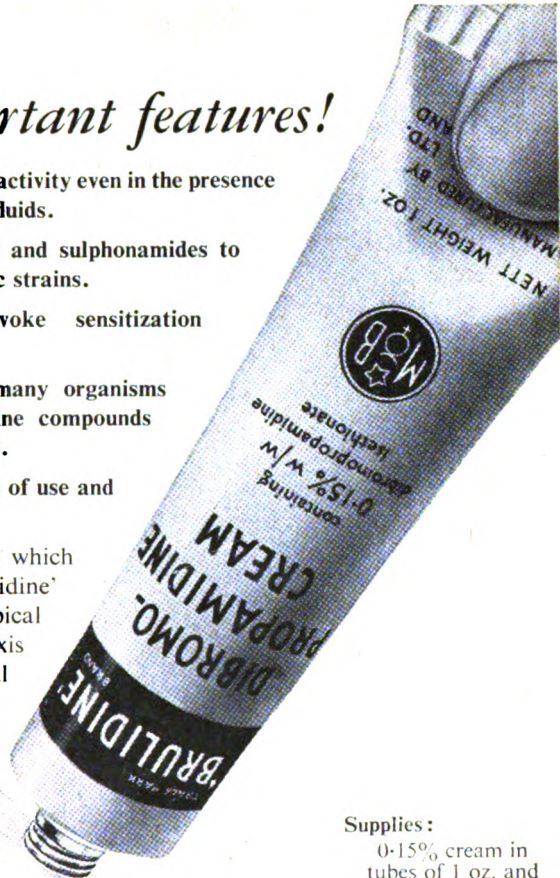
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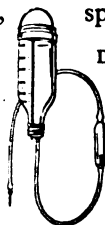
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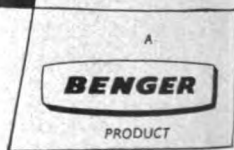
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## *Original Communications*

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### INSECT REPELLENTS AND MITICIDES

BY

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#### EARLY USE OF REPELLENTS

BEFORE the 1939-45 war, naturally occurring essential oils such as citronella, eucalyptus, cassia and many others were in general use as insect repellents. Citronella formed the basis of the majority of proprietary repellents prepared in the form of creams and lotions. Non-toxic and pleasant to use, this substance was effective against many species of mosquitoes for fifteen to twenty minutes, but the necessity for frequent re-application and its pungent odour made it unsatisfactory for continued field use.

Pyrethrum was reported to possess good repellent power and was also in widespread use before the war. The joss sticks or cones which were burnt after dusk in many households in the East to drive away the mosquitoes contained, in many cases, pyrethrum and arsenic (31, 24, 57).

Until 1939, however, there was little stimulus to research into repellents, and no definite results were obtained from work carried out. This was due to the absence of a standard method of testing and the failure to use test insects of a comparable stage of development. The substances tested, principally the essential oils, were not chemically pure, so that conflicting results were reported (8).

The aim of this article is to provide a short account of the work carried out on repellents and miticides since 1939. The importance of both these sub-

stances as a factor in the comfort and efficiency of troops in the tropics and sub-arctic cannot be emphasized too strongly.

#### FACTORS INVOLVED IN THE ATTRACTING AND REPELLING OF INSECTS

In spite of a considerable amount of work carried out in recent years, no conclusive evidence has been obtained about the way in which mosquito repellents act. In the early days when the essential oils like citronella were in widespread use, it was believed that the strong-smelling repellent acted by disguising the smell of the human body : a negative rather than a positive effect. The more recent compounds, however, have little or no odour detectable by man.

The work of Brown and his colleagues (2, 3, 4, 38, 47), using dummy men which could be made to reproduce a variety of natural conditions, has done much to explain the mechanism of attraction of insects to the human body. Working with different *Aedes* species, he was able to show that a moist surface attracted strongly when the atmospheric temperature was above 60° F. Below this temperature, however, warmth by convection was the important factor, and the presence of moisture did not significantly increase the attraction of a warm object. A sweat-soaked jerkin was considerably more attractive than a water-soaked one in a hot atmosphere, but continual sweating reversed the action. Similarly, a warm object attracted most strongly in the temperature range 90-110° F., but over 120° F. it was a repellent. The production of 10 per cent. carbon dioxide from the dummy head in warmed air at a rate of about 2 litres per minute doubled the attractiveness of the dummy for mosquitoes.

The most effective repellents possess the highest vapour repellency power. Maximum activity is displayed by compounds with a high atmospheric boiling-point, chiefly in the range 230-260° C. (42). They presumably act by maintaining an effective vapour concentration over a period of time, without volatilizing rapidly on the warm skin. According to Christophers (8), a repellent should have a boiling-point of at least 250° C. to give an effective protection for two hours, and a boiling-point of 280° C. to protect for six hours.

In field tests, mosquitoes are observed to approach and even to settle for short periods on treated limbs, but blood meals are not as a rule taken until the repellent begins to deteriorate. The wearer usually expects something more dramatic from a repellent, and the fact that insects may settle on the exposed, treated area will upset his confidence in the repellent used (28).

Different people vary enormously in their attractiveness to insects, some individuals receiving far more bites than others in similar conditions. In the same way, different species of insects exhibit different responses to the various repellents. This aspect of the subject is still largely unexplored, but it emphasizes the need for identical conditions in the comparison of effect of the various repellent compounds.

From Brown's work on attractants, it can be seen that a man doing active work, with the requisite production of body heat, carbon dioxide and sweating, is more attractive to mosquitoes than a resting man. But this active man will tend to lose his repellent more rapidly by absorption into skin (21), excessive

sweating (17) and the action of direct sunlight (15). Much work has therefore been carried out in an attempt to find a repellent which would resist these factors and give lasting protection to a man doing heavy work in a tropical climate.

#### LABORATORY AND FIELD METHODS USED FOR TESTING REPELLENTS AND MITICIDES

##### (a) *Repellents*

Granett of Rutgers University was the first to introduce systematic and controlled research in this field. He formulated the properties of the ideal repellent in order to provide a clear aim for investigation. These properties are enumerated below :

- (1) It should have a lasting effect against a variety of insects, preferably for at least twelve hours (overnight).
- (2) It should be odourless or have a pleasing odour.
- (3) It should cause no irritation to the skin even after repeated applications, and should be harmless if accidentally inhaled or swallowed.
- (4) It should have no adverse effect on clothing (staining, bleaching, fibre-weakening, etc.).
- (5) It should not have an objectionable oily appearance or feel on the skin, and should be easily washed off with soap and water, but resistant to sweat and rain (45).
- (6) It should be cheap and easy to prepare commercially from readily available materials.
- (7) It should be stable for prolonged periods in all conditions and climates (24).

Granett also introduced a method for testing repellents using as standard insects *Aedes aegypti* and *Anopheles quadrimaculatus* adult females at identical stages of development. This method was adopted by the Orlando Experimental Station, Florida, where a major part of the basic work on repellents has been carried out (14). The principal criterion in the test was the time taken to the first bite when the forearm, treated with repellent, was exposed to the unfed mosquitoes. Observations were later prolonged beyond this point in order to demonstrate the efficiency and duration of protection.

No substance was accepted for further trial unless the average time to first bite with the different species was more than :

<i>A. aegypti</i>	...	...	...	...	180 minutes
<i>A. quadrimaculatus</i>	...	...	...	...	120 „

It was emphasized that tests must be carried out under constant environmental conditions, and that test individuals must remain in the environment throughout the period of test. This was due to the observed fact that the intensity of repellent effect and its duration varied greatly with these factors.

After laboratory testing at Orlando, the most effective materials were first

examined by the Food and Drug Administration for chronic toxicity and liability to skin irritation in humans. They were then tested in the field on a large scale, and the impressions of the wearer, together with observations on biting rates, were taken in conditions which included heavy sweating.

In the report of the Mosquito Repellent Enquiry at Cambridge (31) it was considered that the "time to first bite" method did not give enough data about the degree of repellency and its effective duration. A different method was described, based on careful recording of the behaviour of *A. aegypti* during exposure to a treated arm.

*(b) Miticides*

With the extension into the far-eastern theatre of the 1939-45 war, the protection of troops against trombiculid mites, vectors of scrub typhus, formed a new and urgent problem. Much of the initial work on this subject was carried out by McCullough, for Australian forces were operating in endemic typhus areas. He demonstrated (28) that effective compounds did not act as repellents but as miticides, immobilizing the mites and killing them before they could attach and transmit the disease.

The Orlando Experimental Station confirmed this finding and evolved a standard method of investigation (33) which depended on the time taken for immobilization of mites introduced on to a square of cloth impregnated with test substance at a dose of 4 ml. (or 4 gms.) per square foot. This "stopping time" provided a good comparison between the efficacy of different miticides, and allowed the rapid screening of a large number of compounds.

It was demonstrated that protection of the wearer could be best assured by the impregnation of the entire clothing rather than by barriers applied at the points of entry for mites (54). This was due to the absence of repellent effect. After preliminary screening by the Food and Drug Administration, the most effective materials were subjected to the following tests with impregnated clothing in field trials :

- (1) The effect of prolonged impregnation with miticides on clothing materials in common use was carefully studied.
- (2) The effect of different clothing materials on the intensity and duration of miticidal effect.
- (3) The effect of heavy sweating, rain soaking, water rinsing and laundering with soap and water on the intensity and duration of miticidal effect.
- (4) The total duration of effect in different clothing materials during continuous wear, with normal laundering every five or six days.
- (5) The personal observations of the wearer, and the effect, if any, of the miticide on his skin, were carefully recorded throughout the period of trial (33).

As with the tests for repellency, great attention was paid to constant environmental conditions, as the stopping times and attachment rates of mites were

shown to vary markedly with humidity, temperature, the time of day, the wearer, and the length of wear and pre-wear of impregnated cloth (20).

#### THE RESULTS OF RESEARCH IN REPELLENTS

After extensive screening of products in laboratory and field trials at the Orlando Experimental Station, four compounds were shown to possess outstanding properties as repellents when applied to the skin, and they were in no way toxic to humans (24, 45). The four repellents are described briefly below :

- (1) *D.M.P.* (dimethyl phthalate) possessed a high degree of repellency to *Anopheles*, *Culicoides* and *Simulium* species, giving an average protection in the field of three hours (1, 9, 48).
- (2) *Rutgers 612* (2-ethyl-1, 3-hexanediol) : Colourless and almost odourless like D.M.P. and with comparable effect. This compound was strongly active against *Aedes* and *Culex* species as well as *Anopheles*. Its repellent action against *A. aegypti* could be prolonged by the addition of an alcohol (24).
- (3) *Indalone* (n-butyl mesityl oxide oxalate) : This material proved to be an excellent repellent against biting flies, especially *Stomoxys* species, an advantage not possessed by the others. Field tests with *Glossina palpalis* showed that indalone was an effective repellent against this tsetse species (15). This repellent undergoes dimerization when exposed to sunlight, and the dimer is inactive, but the repellent effect lasts several hours (18).
- (4) *Dimethyl carbate* (cis-bicyclo, 2, 2, 1-5 heptane-2, 3-dicarboxylic acid dimethyl ester) was not used so frequently as the others, although it replaced Rutgers 612 when the latter was in short supply. It was shown to be the most effective of the repellents against Alaskan mosquitoes (average time to first bite one hour twenty-five minutes against nineteen minutes for D.M.P. (1)).

These four were all non-toxic, but were all plastic solvents. They should therefore be kept away from fountain pens, spectacle frames, watch-glasses, nylon and artificial silk stockings, etc. Contact with mucosæ or conjunctivæ may give rise to intense local irritation, and Rutgers 612 often may produce a burning sensation when applied to sore or sunburnt skin (24, 45, 53).

Further investigation showed that mixtures of three (ternary) of these repellents gave better results than the individual repellencies would lead one to expect, indicative of synergistic action. The most effective mixture in laboratory and field tests was 6-2-2, consisting of :

D.M.P.	...	...	...	6 parts by weight
R.612	...	...	...	2 " " "
Indalone	...	...	...	2 " " "

This repellent mixture, which became the standard U.S. Army issue during the war, gave full protection for at least four hours against a wide range of

insects. This included most species of mosquitoes, midges, biting flies, simuliids and the larval and nymphal forms of ticks. Trombiculid mites were immobilized and killed (13, 24, 30, 34, 45, 48). The wide range of nuisance and disease-vector insects repelled by 6-2-2 made this mixture a more effective all-purpose repellent than D.M.P. alone. The latter, however, was cheap and readily available commercially and it has proved its efficiency in the field as a universal issue in the British Army.

#### THE RESULTS OF RESEARCH IN MITICIDES

In the early part of the war, research on miticides was retarded by the discovery that the established repellents, D.M.P. and 6-2-2, were efficient in this respect, making possible a single, all-purpose issue to troops. There was considerable variance in opinion about the duration of miticidal effect of D.M.P. in impregnated clothing, as the following reports from different sources show, but all were agreed that the repellents would not withstand laundering, which reduced their value in the field.

- (1) Sprinkled evenly over clothes (24 ml. average dose), the effect of D.M.P. lasted up to eight days, but washing of clothing reduced the safe period to two days (54).
- (2) Impregnation with a 5 per cent. emulsion (soap) of D.M.P. lasted five weeks against sun, rain, walking in wet grass, excessive sweating, but would not withstand laundering with soap (62).
- (3) Applied as an emulsion to outer garments, D.M.P. was effective up to four weeks in unwashed clothing. It lost its efficacy rapidly after wading in water, drenching with tropical rain or sweat, and laundering with soap and water. Rutgers 612 was shown to be as effective as D.M.P. (26).

In Australia, work was carried out to find a substance which would resist laundering and drenching. Dibutylphthalate (D.B.P.) was found to be as effective a miticide as the related compound D.M.P. with much better lasting properties. It was shown that D.B.P.-impregnated clothing retained its miticidal effect through eight washes and was unaffected by heavy rainfall and sweating. In 1943 D.B.P. was manufactured on a large scale in Australia and issued to troops with simple instructions for fortnightly impregnation of clothing in the field (see "Application of Miticides" later) (8, 25, 54).

Meanwhile, at the Orlando Experimental Station extensive screening of compounds began in the hope of discovering an efficient miticide which would withstand repeated heavy laundering. Four substances were finally selected for further testing, and these are listed below :

- (a) *D.M.P.*—A very efficient miticide before laundering. In view of its excellent mosquito repellency, tests were initiated to try and prolong its persistence in cloth so as to give a double effect.

- (b) *D.B.P.*—This substance was included because it was used extensively by the Australian forces, with reported good resistance to washing. It was of no value as a mosquito repellent.
- (c) *Phenyl cyclohexanol.*—This was found to be a good miticide with lasting properties and also a mosquito repellent similar in efficacy to Rutgers 612. It possessed the disadvantage that it occasionally gave rise to irritation of hands and face.
- (d) *Benzyl benzoate.*—This was the most effective miticide of all with the best resistance to laundering. It was, however, of no value as a mosquito repellent (33).

Crude benzene hexachloride (B.H.C.) containing 12 per cent. of the gamma isomer was also found to be a very efficient miticide. It worked both by contact and fumigant action with good residual effect through several launderings. It was abandoned as a clothes impregnant because of its toxicity and the intense irritation caused to skin and eyes. Its use, however, when applied as a dust (10 lbs. per acre) to mite-infested areas produced effective control of mites in the field.

Further testing of the four selected miticides gave the following results :

- (a) *D.M.P.*—The efficacy was lost after a single laundering of impregnated clothing in warm soapy water. Further work to find a method of prolonging its persistence in cloth failed, so D.M.P. was considered unsuitable for use (55).
- (b) *D.B.P.*—Results obtained were variable and disappointing. It was less effective initially as a miticide than D.M.P. (stopping time six minutes against less than two for D.M.P.).
- (c) *Phenyl cyclohexanol.*—Similar to D.B.P.
- (d) *Benzyl benzoate.*—This was by far the most effective, and clothes treated with 5 per cent. emulsion were still highly miticidal after three heavy launderings with warm soapy water (33).

Benzyl benzoate was then tried out exhaustively under field conditions to determine the effect on the clothing and on the wearer, and also the duration of miticidal effect of impregnated clothes during long periods of wear and repeated heavy launderings. The results of this investigation are tabulated below :

- (1) No skin lesions of any sort or skin irritation could be attributed to benzyl benzoate after sixteen weeks of trial.
- (2) The clothing was laundered thoroughly every five to six days, and benzyl benzoate alone lasted through three to four washes. An emulsion containing 5 per cent. benzyl benzoate with 5 per cent. vinylite resin as a binder lasted through five washes.
- (3) Impregnated clothing was slightly warmer than the untreated, but no characteristic of the benzyl benzoate impregnated clothes rendered them any more unsuitable for tropical wear than untreated clothes.



- (4) The lower limit of miticidal activity was a concentration of 0.1 per cent in the clothing. Below this figure protection could not be guaranteed.
- (5) Even wool garments impregnated with benzyl benzoate showed satisfactory in miticidal properties, but were slightly less resistant to laundering than cotton garments (7).

In subsidiary tests against ticks, benzyl benzoate was the best of all materials tried, and impregnated clothing gave protection for at least eight days (more effective and for longer duration against larval and nymphal forms than against the adult ticks) (36).

Benzyl benzoate was therefore adopted for use as a miticide by the U.S. Army. When in scarce supply, it was mixed in equal parts with D.B.P., as it was shown that the miticidal activity and duration of benzyl benzoate was unaffected in this combination (52).

#### METHODS FOR THE APPLICATION OF SKIN REPELLENTS AND CLOTHING IMPREGNANTS

Before the problem of mite-borne typhus arose in the early part of the 1939-45 war, repellents applied to the skin at regular intervals were considered to give adequate protection. The successful impregnation of clothing with D.B.P. by the Australian forces led to a search for some compound as clothing impregnant which, combined with an effective skin repellent, would give complete protection to the wearer from assault by any of the variety of disease-carrying and nuisance insects. It was soon observed that the vehicle in which a repellent was made up was an important factor in its efficiency and persistence, as also was the method of impregnating clothing and applying the repellent to the skin. These factors are considered briefly in the ensuing paragraphs.

##### *(a) The Application of Repellents*

D.M.P. and 6-2-2 in pure, liquid form were found to be satisfactory for field use and were extensively employed during the war. Observations in the field, however, showed that, on the sweating skin, the repellents tended to drain or "creep" (31) to the dependent parts of areas treated, and were removed by friction against the clothing or the action of wiping away excess sweat. At the same time, even the most efficient repellent was eventually washed away by heavy sweating during exertion, or underwent deterioration in the direct sunlight. Re-application was therefore necessary every one to one and a half hours instead of the three hours which was the safe limit in the laboratory experiments (15, 17).

Research was therefore instituted in an attempt to find a suitable vehicle which, in individual containers, would be stable in all climates, which would maintain or even potentiate the effect of the incorporated repellent, and which would be resistant to washing off by heavy sweat and, if possible, to rubbing off by the friction of the clothing.

The preparation of repellents in cream form not only improves the cosmetic appearance but also often enhances the efficiency of the repellent by extending

the duration of its effect (24). The Mosquito Repellent Enquiry at Cambridge (1943-45) revealed that lotions, ointments with petroleum jelly base and vanishing creams were on the whole unsatisfactory as vehicles for D.M.P. Clay pastes, with the addition of shellac to form a rub-proof skin, tended to reduce the repellent effect. A cream with a waxy consistency (see No. 2 below) appeared to give the best results (31). It has also been observed that, to be effective against midges, the proportion of active ingredient should not fall below 40 per cent. v/v (48), but this does not seem to be universally applicable.

Four different specifications for creams which remain stable and have stood up to exhaustive tests are listed below :

1. D.M.P.	70	2. D.M.P.	12.5	3. D.M.P.	50	4. D.M.P.	33
Mag. stearate	30	White wax	9	Unemul	40	Bentonite	65
		Arachis oil	27.5	Prolein	10	Cal. stearate	2

The first three creams (31) were shown to undergo no deterioration over a two-year test period ; they were easy to apply and were as effective as pure D.M.P. throughout the test. The fourth cream was put out by Orlando and was claimed to prolong the repellent action of D.M.P. up to six hours in the field (44).

Certain practical points were raised with reference to the application of repellents to the skin. First, to obtain good effect the repellent should not be dabbed on here and there, but should be applied evenly over all exposed surfaces. Second, when the skin is hot and moist with sweat, a feeling of complete cover is given by application of too small a dose of repellent to be effective. These points, combined with the fact that there is frequently no *apparent* mosquito nuisance in highly malarious areas, led to irregular and inefficient application of repellent, which could only be remedied by good discipline (28).

It was observed that direct application of 20 ml. D.M.P. to shirt and trousers by shaker bottle protected the wearer against *Aedes* bites for two to three days (28). It should be remembered, however, that D.M.P. is a plastic solvent, and any nylon or other synthetic fibres in the cloth may be damaged by impregnation (27). The brief endurance, moreover, of D.M.P.-impregnated clothing in strenuous circumstances of wear in the field limits its value in this respect.

Spraying with D.M.P. of anti-mosquito sleeping nets with a wide mesh of  $\frac{1}{4}$  inch has been reported to repel mosquitoes for several days, allowing for cooler sleeping than under the standard net (45). Based on the results of work carried out by the Medical Research Institute of India, veils, gauntlets and overboots consisting of  $\frac{1}{4}$ -inch mesh netting impregnated with D.M.P. were introduced. These items, packed in small wallets, were issued to British troops operating in malarious areas as "individual anti-mosquito outfits," and proved invaluable in forward areas where other means of protection were impracticable. The outfit was re-impregnated weekly with D.M.P. (or more frequently if in constant use) (8). More recently it has been shown that protective netting, impregnated and kept in small, air-tight tins (*e.g.*, flat 2-ounce tobacco tins), will retain its

repellent power for ten to twenty days (48). There are certain disadvantages to this form of protective clothing. The veils may give rise to headache, but if worn well away from the face should be imperceptible. Gloves and veils may catch in undergrowth during active duty in jungle warfare but when used with discretion for sleeping in forward areas and for protection of wounded, the outfits can be of greatest service to the soldier. They should, of course, be used in conjunction with an effective skin repellent.

It was later demonstrated that D.M.P., when applied to clothing at a dosage of 4 c.c. per square foot, was completely repellent to land leeches for as long as six days. Special attention should be paid to treatment of the tongue, lace-holes and neck of shoes or boots ; to the socks and the lower part of the trouser legs (41). This was a valuable protective as terrestrial leeches can be the source of considerable trouble to travellers or troops in jungle conditions.

### *(b) The Application of Miticides*

It has already been observed that the repellents in general use in the war, D.M.P. and 6-2-2, were effective as clothes impregnants against mites. The repellents were applied by drawing the mouth of the issue bottles over clothing, especially at the probable points of mite entry. This was a simple method, requiring no special equipment and no fresh issue of a specific miticide (33).

Following McCullough's work, however, in which it was shown that D.M.P.-impregnated clothing would not withstand tropical conditions and laundering, D.B.P. was issued to troops at a scale of 2 ounces per man per fortnight. The liquid was poured into a tin lid, the fingers dipped into it and the miticide applied in smears with a stroking motion over the cloth. On the average, 1 ounce was equivalent to 75 smears, and direct application was made to the clothing in the following routine manner :

6 smears each sock (or boots, if socks not worn) ;	
10 smears each trouser leg ;	
10 smears on trouser waist and fly ;	
6 smears each shirt sleeve ;	
20 smears on body of shirt.	
10 smears on underpants )	An extra $\frac{1}{2}$ ounce per man per fortnight required if these to be treated in addition.
10 smears on singlet )	

Two sets of clothing were impregnated at the same time and worn alternately. Thus, when the clothing was washed daily after wear, the fortnightly re-application followed seven washes and seven days of wear of each suit of clothes (54).

The researches at Orlando led to the adoption by the U.S. Army of benzyl benzoate, already in extensive use as an acaricide, as a clothing impregnant. It was shown to give consistently good results even after heavy laundering and the most strenuous of field conditions. It was supplied as an emulsion concentrate :

Benzyl benzoate	...	...	90
Emulsifier	...	...	10

(Tween 80 or Tween 60 were used, or equal parts of each if sea water to be used in dilution.)

The concentrate was diluted with water to 5 per cent. (about  $\frac{1}{2}$  pint to 1 gallon of water), and the clothing impregnated by dipping and allowing to dry (10). In the preparation of emulsion from the concentrate, it was recommended that equal quantities of concentrate and water should first be shaken together to produce a creamy emulsion before final dilution to the required proportions.

It was also recommended that, as an added protection, the clothing treatment should be combined with the dusting of D.D.T. powder (10 per cent. in talcum) in the socks and shoes. This retained its miticidal effect through at least two launderings (40).

It was observed that a mixture of D.B.P., benzyl benzoate and an emulsifying agent (45 : 45 : 10) gave equally good results as an emulsion, withstanding sun, rain and several weekly launderings. This concentrate was also on issue by the U.S. Army Quartermaster when benzyl benzoate was in short supply.

#### RECENT DEVELOPMENTS

In recent years much attention has been given to the development of an all-purpose impregnant for clothing which will be effective as a repellent against mosquitoes (including the sub-arctic species), biting flies, ticks, fleas and mites. This, combined with a good skin repellent for the exposed parts, should give complete protection for the wearer in all circumstances against the bites of nuisance and disease-carrying insects.

Smith and Cole (50) screened a number of known repellents in both laboratory and field tests. Stockings were impregnated with the repellents at a dosage of 2 and 3 gms. per square foot, worn for successive eight-hour "wear periods," and then tested in the field against salt-marsh mosquitoes for five minutes each on three different persons. Compounds were excluded which did not maintain a high repellency after three successive periods of eight hours' wear, which caused irritation or were toxic to the wearer, which stained fabrics or had a strong odour. 2-butyl-2 ethyl-1, 3-propanediol gave excellent protection after fifty-six hours' wear (3 gms. per square foot) and thirty-two hours' (2 g. per sq. ft.), and indalone after forty-eight and sixteen hours' wear respectively. D.M.P. and repellent 6-2-2 gave only short protection at the higher and none at the lower dosage.

Indalone and 2-butyl-2 ethyl-1, 3-propanediol were then combined with the best tick and flea repellents and miticides in different proportions in the search for a good all-purpose clothing treatment. The most successful mixture was M.1960, consisting of :

2-butyl-2 ethyl-1, 3-propanediol	...	...	...	30
N-butylacetanilide (ticks and fleas)	...	...	...	30
Benzyl benzoate (miticide)	...	...	...	30
Tween 80 (emulsifier)	...	...	...	10

This mixture, tested against *A. quadrimaculatus*, *A. aegypti* and salt-marsh mosquitoes, proved to be a more efficient and longer-lasting repellent against each of the three species than any individual repellent, including D.M.P., Rutgers 612, indalone and the mixture 6-2-2. Its effect against ticks, fleas and mites was assured by the inclusion of N-butylacetanilide and benzyl benzoate (50). These results were later confirmed by Smith and Gilbert (51).

The standard dosage of M.1960 as a clothing impregnant varies with the type and weight of cloth to be treated, as shown in the following table :

Type of cloth	Weight of cloth (lbs.)	M.1960 Concentrate (gallons)	Water (gallons)	Proportion of M.1960 in emulsion per cent.
Cotton ... ..	60	1.5	4.0	27.3
Woollen ... ..	60	0.75	6.75	10.0

To prevent wastage of M.1960, simple instructions have been issued by the Bureau of Entomology and Plant Quarantine for re-use of emulsion residue after one clothing treatment (62).

A recent study in North Borneo has demonstrated that M.1960-impregnated clothing is completely effective against terrestrial leeches even after five washes and exposure during heavy rains. One gallon of the emulsion concentrate was sufficient when diluted with water for the treatment of twenty-eight uniforms (56).

Further screening of compounds at Orlando revealed that benzyl p-chlorobenzoate was as effective a stopping agent to mites as benzyl benzoate. Mixed in equal parts with benzyl benzoate, the miticidal effect of impregnated clothing lasted through at least three more launderings than the benzyl benzoate by itself (35). Another compound, benzil, was even more efficient, still retaining 97 per cent. of its miticidal activity after ten launderings (11).

As a help to future laboratory procedures, it has been demonstrated (21) that tests for the screening of repellents and observing their mode of action can be carried out with guinea-pigs, which reproduce approximately the same results as in man. This method has the advantage that smaller amounts of the test compound are necessary and toxicity to the host is not such a major consideration.

#### CONCLUSION

There is no doubt that the protection of troops from disease-carrying and nuisance insects is a vital factor in promoting their efficiency in both tropical and sub-arctic conditions. In the light of laboratory research and field experience, such protection can be assured by the combination of an effective skin repellent with a clothing impregnant.

No skin repellent has yet been described which can guarantee its wearer full protection through the hours of sleeping, so that reliance must be placed for this purpose on mosquito nets and individual anti-mosquito outfits which have proved their efficacy in the field. The repellent mixture 6-2-2 protects

against a wider range of biting insects than D.M.P. alone, and its effect is of longer duration. D.M.P., however, is readily available in pure form ; the effect of heavy sweating and the direct rays of the sun on the repellent reduces the significance of the slightly longer action of 6-2-2.

Attempts to discover a vehicle which would prolong the action of D.M.P. by preventing loss due to sweating and direct friction have been disappointing in their results, although the wax-arachis oil base cream and the bentonite-calcium stearate paste (described above) are worthy of trial under tropical conditions. In the absence of a suitable vehicle, the skin repellent is best issued in pure liquid form as at present.

With regard to the impregnation of clothing, D.M.P. is unsuitable for general issue as it will not stand up to tropical conditions and the frequent laundering which they necessitate. Benzyl benzoate, already in general use as an acaricide against scabies, has been exhaustively tested and is a reliable miticide which will withstand long wear and many washes. The most suitable form of issue is an emulsion concentrate (Benzyl benzoate 90, emulsifier 10) which can be diluted in the field ( $\frac{1}{2}$  pint to 1 gallon of water) for the impregnation of clothing.

It is unfortunate that no all-purpose compound has yet been described which can be used with equal effect as skin repellent and clothing impregnant, with all the advantages of a single issue for a dual purpose. The ideal repellent has yet to be discovered, and there is still considerable scope for research in this subject.

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# VIRUS JAUNDICE, PARTICULARLY ARSENOTHERAPY JAUNDICE, AMONG THE FORCES IN CYPRUS DURING THE LAST WAR

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## DISCUSSION

It has been shown by Dible *et al.* (1943) and Mallory (1947) that the histological changes in the liver in IH, SH, and AsJ are so similar that they cannot be differentiated. Dible and McMichael (1943) have also shown that in a patient with untreated secondary syphilis who developed jaundice the hepatic histology was identical with the other forms of hepatitis. Various theories of the cause of AsJ have been put forward. They may briefly be summarized as follows :

- (1) *Syphilis* (Milian, 1914, 1920 and 1934 ; Milian, Lotte and Delarue, 1928).—The theory of "hepatorecurrence" has been disposed of (Soffer, 1937, and others) and syphilis is not now regarded as a possible cause in patients undergoing adequate treatment.
- (2) *Infection with the Virus of IH or SH or Similar Organism.*—
  - (a) *Already present* in the patient and becoming "activated" by treatment (Anwyl-Davies, 1942). There does not appear to be any evidence to support this.
  - (b) *Intercurrently.* A few must certainly be of this type.
  - (c) *Introduced by faulty injection technique* (MacCallum, 1943 and 1945, and Bigger, 1943). This is undoubtedly the cause in a large number of cases.
- (3) *Drug.*—It seems probable that in man arsenicals are seldom, if ever, the sole cause of hepatic damage and there is general agreement that the quantity of arsenical bears no relation to the incidence of jaundice.
- (4) *A Combination of (2) (b) or (c) and (3)*—
  - (a) Effects of the drug predisposing to infection (McDonald, 1918 ; Stokes *et al.*, 1920 ; Ruge, 1927).
  - (b) Effects of infection predisposing to the drug (Borensztejn, 1948).

The subject has been reviewed by Peters and his co-workers (1945) and in a memorandum by medical officers of the Ministry of Health (1945). Although the relationship of the infecting agent in AsJ with that of IH or SH has not yet been precisely determined, there is increasing evidence that it is commonly similar to or even identical with the second.

The technique for intravenous injections in use at the Venereal Disease Centre in Cyprus during the period under review differed little from that in common use at the time. Before the injection of arsenical a little of the patient's blood was drawn into the syringe. Afterwards the needle was washed and boiled and the syringe was washed three times with distilled water and once with alcohol. Such a procedure does not adequately clean a syringe (Bigger, 1943). Although it can safely be assumed that a large number of the cases of AsJ in Cyprus were caused in this way, there are grounds for believing that other ways of spread may have existed.

The incidence of AsJ was not constant throughout the year. It began very low, rose to a peak and fell again, the curves being similar to those for IH, but with a lag of two to three months. A correlated increase in AsJ and IH in the general population has been noted by Stokes *et al.* (1920) and Ruge (1927). A similar relationship was found in a military unit by Coleman (1944). Although the incubation period of IH transmitted by inoculation to volunteers is sometimes much longer than by natural infection (Neefe, 1946; MacCallum, Stewart and Bradley, 1951), to explain this relationship on the basis that AsJ was due to IH spread by inoculation or contact would require immunological support which is not forthcoming. Further, a close temporal relationship is not always found between AsJ and IH (Soffer, 1937).

Although IH increased seasonally in British troops with a corresponding rise of AsJ, the autumnal increase in AsJ among the Indians was not matched by any marked rise in IH among healthy Indian troops. In the latter half of the period there were four times as many Indians on the syphilis register each month as at the beginning, which may account in part for the increase in Indians with AsJ at this time. The monthly variation in the numbers of British and Cypriots undergoing arsenotherapy was comparatively small. Infective jaundice was much commoner among men receiving arsenic than among healthy troops—11 times commoner for the British, 20 times for the Cypriots and 33 times for the Indians. Ruge (1927) found jaundice to be 16 times more frequent among naval ratings under arsenical treatment than in an equivalent healthy naval population. Mitchell (1943) concluded that in the Canadian Army the respective figure was 36.5.

There is not much information about racial and immunity factors in the incidence of different forms of virus jaundice. In the last war IH was ten times commoner in white American troops than coloured, although there was said to be no difference in work or feeding habits (Witts, 1944). In Cyprus nearly six healthy (white) British troops contracted IH for every healthy Indian or Cypriot. Here the work and living conditions varied somewhat. The relative immunities of peoples native to, and of immigrants into, endemic areas of IH have been considered by Cameron (1943) with regard to Palestine. Goodman and Gilman (1941) report the incidence of AsJ in white Americans as three times that in coloured. Soffer (1937) found the same ratio at Johns Hopkins Hospital. There was a similar situation in Cyprus, where British troops were two or three times more prone to AsJ than Indians or Cypriots. On the other hand, Paul

and Gardner (1950) found no difference in the attack rates for white and coloured American troops in Germany from 1946 to 1950. Where they exist, racial variations in incidence may indicate either different causal viruses with racial immunity differences, or differing hepatic effects of arsenicals, or both. It is doubtful if inadequate nutrition is a factor increasing the liability to jaundice.

If inoculation had been the only means of spread, the incidence of AsJ in sub-groups should have been the same. The jaundice rate varied not only in different racial groups but, which is more difficult to explain, in sub-groups of the same race. This was particularly noticeable among Indians under treatment who worked in the medical services. The possibility of transmission of AsJ by contact must be considered, especially when it may be due to IH, a possibility during an epidemic. An episode which was thought to suggest this mode of spread was reported by Richards (1933) and quoted by Cullinan (1939) and Findlay (1939). Richards described a high rate of jaundice (one in three) among male patients at his venereal disease clinic during 1931 to 1933. The rate fell rapidly after the waiting accommodation was changed from a crowded passage to a well-ventilated out-patient hall. However, Richards now believes (personal communication) that the successful termination of the epidemic was in fact due to stricter methods of antisepsis, including the boiling of syringes after use, and that it was the long incubation period of SH which made these measures appear initially as of no avail. The conditions at the treatment centre in Cyprus were favourable to the spread of infection by contact. The British and Cypriot patients were injected on Saturday mornings between nine and noon; Indians on Wednesdays at the same hours. The members of each group waited together, sometimes for upwards of one hour. In summer they usually sat on the veranda outside, but in autumn and winter when the weather was cool and wet a small waiting-room was used. Both IH and AsJ were commonest in the late autumn. Findlay believed that the transmission of AsJ and SH by contact must be considered a possibility (Findlay, 1939; Findlay, Martin and Mitchell, 1944). He has shown (Findlay and Martin, 1943) that nasal washings from early cases of SH instilled into the nares of healthy volunteers can produce an illness like IH after an incubation period of 28 to 50 days. Stokes *et al.* (1920) report one possible case of contact spread of AsJ. Probert (1938) noticed jaundice in contacts of children with SH in an institution (see McFarlan, 1951). Neefe, Stokes, Reinhold and Lukens (1944) report instances of an IH-like illness in two close contacts of a volunteer with SH. Droller (1945) reported jaundice in two contacts of patients thought to have SH contracted at a diabetic clinic. The high rate of AsJ in troops in Cyprus who tended patients and who were therefore more often in contact with cases of jaundice is suggestive of contact spread of the disease and that the arsenicals may have been predisposing agents. There was some evidence that healthy troops, especially Indians, in contact with patients had a higher jaundice rate than others. This suggests that jaundice in syphilitic medical personnel was more often due to IH than in similar non-medical troops. As already noted, in two of the patients reported the AsJ may have been due to IH. The subject is discussed by McFarlan (1951),

who points out that until it is possible to differentiate IH and SH by laboratory tests, definite conclusions about their modes of spread cannot be made.

It is generally agreed that arsenicals are seldom if ever a direct cause of liver damage leading to jaundice, apart possibly from the mild transient type seen sometimes at the start of treatment and termed "Milian's jaundice" (*Medical Research Council Special Report No. 66, 1922, and Peters, 1941*). Even in cases where hepatic damage has been severe and rapidly fatal there is no evidence that arsenic plays a leading role. An Indian was taken ill in January, 1943, while under arsenical treatment for syphilis, and died a few days after admission to hospital. He suffered from few of the usual symptoms of hepatitis and was clinically never jaundiced. Histological examination showed very extensive diffuse hepatic necrosis and some bile staining of the remaining liver cells and of renal tubular epithelium. Although very severe, the hepatic lesions were unlike those in animals dying from the toxic effects of massive doses of arsenicals. Such a mode of death is uncommon in virus hepatitis and is presumably dependent on the speed and extent of hepatic necrosis. Lucké and Mallory (1946) showed that SH was more likely to produce rapid ("fulminant") hepatic death than IH. They describe three cases of anicteric fatal hepatitis.

Determination of the role of arsenicals as possible predisposing agents in the production of AsJ is hindered by lack of decision as to the identity of the viruses in this condition and in IH and SH. If these diseases are caused by the same virus, then differences between them could be ascribed to some extraneous factor such as the arsenical; but if the viruses are separate entities, any clinical differences might be due to properties of the organisms. Various workers have found that tests of hepatic function may be abnormal during arsenotherapy and such findings have been adduced as evidence of arsenical damage. Gerrard (1924) found a rising concentration of serum bilirubin in a number of patients as treatment advanced. These findings were confirmed by Dixon, Campbell and Hanna (1926). It was found by Biskind, Epstein and Kerr (1933) that there was an increasing inability on the part of the liver in some patients to excrete the dye Rose Bengal during arsenotherapy. Riddell and Anderson (1944), using the hippuric acid test, demonstrated impairment of hepatic function as long as five weeks before the onset of jaundice. Peters and his co-workers (1945) found an excess of urobilinogen in the urine of some patients up to six weeks before the onset of jaundice accompanied by prodromal symptoms.

Although the finding of abnormal liver function tests during arsenotherapy might indicate direct damage by arsenicals, another explanation is that the affected patients were incubating SH. The fact that with or without cessation of treatment jaundice fails to develop does not exclude this possibility, as Neeffe *et al.* (1944) have shown experimentally that SH may occur without jaundice. When arsenotherapy is withheld, jaundice may not develop and liver function tests may revert to normal, while in other cases the clinical condition of hepatitis with jaundice develops (Beattie and Marshall, 1944b). Clinical and biochemical abnormalities occur in AsJ many weeks before the onset of jaundice, but SH has a long incubation period and prodromata may occur weeks before the

clinical onset of this disorder. Findlay *et al.* (1944) found that in hepatitis after yellow fever inoculation symptoms occurred up to 56 days before the onset of jaundice. Neefe *et al.* (1944) found abnormal liver function tests in volunteers with SH long before the appearance of jaundice. More recently Jersild (1947) has described a severe form of hepatitis in Denmark in which prodromata lasted as long as two months. This is of especial interest as there was no indication that homologous serum had been administered to his cases and the disease was presumably due to a severe form of IH. The presence of prodromata in AsJ, therefore, does not necessarily mean that arsenicals have damaged the liver. Nevertheless, it is difficult to believe that arsenicals play an entirely neutral role in AsJ. Thus Case 1 was the only patient in the hospital to contract jaundice when the cook was taken ill with IH. It is conceivable, although unlikely, that the prolonged hepatic enlargement was a prodromal feature of AsJ. Two of the patients reported here (Cases 2 and 11) gave histories of increasing symptoms after each injection of arsenical given during the incubation period of their hepatitis. A different incident was reported by Parnell and Fildes (1919). Two patients developed jaundice 17 and 24 days respectively after their first injection of arsenical. In one the jaundice lasted over three weeks and in the other for five and a half weeks. It seems unlikely that these were instances of "Milian's jaundice." Wile and Sams (1934) describe a case who developed jaundice after the first injection of arsenical for six months and who died with acute yellow atrophy of the liver. These patients may have been incubating IH or SH.

Beattie and Marshall (1944b) found that if patients with prodromata were given further treatment they nearly always developed jaundice, but that fewer did so if arsenicals were withheld. Damodaran and Hartfall (1944) reported rapid worsening of the patients' condition under similar circumstances. An interesting episode was reported by Borensztejn (1948). Of 216 subjects who attended a venereal disease clinic and who contracted jaundice, only 120 had been given arsenicals. The remaining 96 simply had routine blood tests after gonorrhœa. It is probable that a large proportion of the patients with syphilis were infected with the same strain of virus as those who only had gonorrhœa. The illness in the 120 patients with AsJ was found to be "very severe" and 30.8 per cent. died. The 96 with SH were less ill and only three died. These facts suggest that arsenotherapy during the incubation period of hepatitis has a damaging effect on the liver, and that AsJ may be more severe than SH.

Arsenicals administered during or soon after an attack of AsJ may have serious consequences. In the early days Milian (1914, 1920 and 1934) was the protagonist for continuing arsenical treatment in jaundiced patients on the grounds that the jaundice was syphilitic in origin and that it was improved by the treatment. Stokes *et al.* (1920) produced no ill-effects by continuing treatment in some patients, but those who have adopted this course have usually had unpleasant experiences, although a large number of patients have apparently recovered normally from the jaundice. Milian (1914 and 1934) and Milian *et al.* (1928) record instances where patients died or were made worse by such treat-

ment, although Milian seems sometimes to have been misquoted in that clinical deterioration was not always due to continued arsenotherapy. Among his writings is a record of interest (Milian, 1919). The patient had secondary syphilis with jaundice, but had received no arsenical treatment. After each of the first five injections of novarsenobenzol, the patient experienced immediate rigors, vomiting, headache and fever. Jaundice deepened, the liver became considerably enlarged and the patient's condition deteriorated, though ultimately the arsenical was tolerated. It is difficult to escape the conclusion that it played some part in these incidents. Sicard *et al.* (1919), dissenting from Milian's views, stated that they had seen fatal acute yellow atrophy of the liver in patients who had continued arsenotherapy when jaundiced. Wile and Sams (1934) reported that of five patients who were inadvertently given further arsenotherapy when mildly jaundiced, one died in five days of acute yellow atrophy of the liver. It was the experience in Cyprus that those patients who were given arsenicals after the appearance of hepatitis were worse within twenty-four hours, although some recovery occurred over the next few days. Further, such patients were among those most severely affected by the AsJ. In such cases the clinical changes were so closely related in time to the injections as to leave no doubt of the ætiological part played by the arsenicals. Beattie and Marshall (1944a), assessing the evidence, thought it dangerous to continue arsenotherapy during AsJ. The practice has been given up.

The jaundice may relapse after an attack of AsJ, as occurred in Case 6 without further administration of drug. It is uncertain whether this is always due to relapse of the AsJ. It may sometimes be due to IH, such as was possible in Case 8. It has been shown by Neefe, Stokes and Gellis (1945) that one attack of SH protects against another, but not against IH. However, this may not be relevant to AsJ. Relapse after restarting arsenotherapy is too frequent and such cases are too severe to allow the drug to be excluded entirely as an ætiological factor. Case 14 had a severe relapse after a second course of arsenotherapy begun within a month of recovery from the first attack. Mitchell (1943) reported one death from acute yellow atrophy of the liver with jaundice following such a relapse. Marshall (1943) found four relapses of jaundice in 273 cases of AsJ on restarting arsenotherapy. Soffer (1937) reported that of 81 cases of AsJ who subsequently received further treatment, two had a return of jaundice, in both instances directly after the first injection. One of these had two prompt recurrences on each of two occasions after the administration of arsphenamine. For practical purposes it is wise to withhold arsenicals for at least three months after recovery from AsJ.

There seems therefore to be evidence of a connection between arsenotherapy and the production of hepatic lesions. The injection of infected material along with the arsenical is the usual mechanism, but there are two subsidiary possibilities. Either the arsenical sometimes acts directly on a healthy liver, rendering it more susceptible to a hepatitis virus, and there is little evidence for this, or an incubating infection may lay the liver open to damage by arsenicals which would not hurt a normal organ.

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## SUMMARY

Figures are presented showing the incidence of virus jaundice in healthy and syphilitic British, Indian and Cypriot troops in Cyprus between May, 1942, and April, 1943. There were 186 cases of IH among healthy British troops (an incidence of 3 per cent.), 61 among Indians (0.55 per cent.) and 10 among Cypriots (0.51 per cent.), a total of 257. The attack rate for British officers was about three times that for British other ranks. Two-thirds of the British cases occurred between September and January. These figures were similar to those generally found in the Middle East in 1942 and 1943. There was one death (Indian). British troops were nearly six times more likely to contract IH than Indians or Cypriots.

Twenty-two cases of jaundice occurred among syphilitic British troops undergoing arsenotherapy, 49 among Indians and 4 among Cypriots, a total of 75. Various factors made exact measurement of the incidence of AsJ difficult, but it was considered that it could not have been lower than 32.3 per cent. in the British troops receiving treatment, 18.2 per cent. in the Indian and 10.3 per cent. in the Cypriot. Two Indians died of hepatic necrosis while under treatment. Taking all the cases together, there was a lag of between two and three months in the rise and fall of AsJ in relation to IH. AsJ in British troops was three times commoner than in Cypriots and nearly twice the Indian figure. It was nearly twice as frequent in Indians as in Cypriots. AsJ among British troops was nearly 11 times, among Cypriots 20 times and among Indians 33 times greater than IH among similar groups of healthy men. Racial variations in the incidence of AsJ remain unexplained.

British and Indian personnel handling patients were probably more liable to contract IH than others. Syphilitic Indians undergoing arsenotherapy in contact with patients were five times more likely to contract jaundice than those engaged in non-medical work.

The literature dealing with the clinical features of different forms of virus jaundice is discussed. Any form of virus hepatitis may vary in clinical severity at different times and in different places. The clinical manifestations of 30 cases of IH and 14 of AsJ occurring at the same time are compared. Considerable differences in degree were found in the behaviour of the jaundice and anorexia,

in hepatic, renal and hæmorrhagic manifestations, and in the length of illness. The mode of onset of AsJ sometimes differed from that in IH and the course was often variable and usually prolonged. There was a higher proportion of ill patients among the AsJ group. Among the most ill were three who had arsenical injections after the onset of clinical hepatitis. Doses of arsenical produced increased reactions during the weeks preceding the onset of the hepatitis in two patients. Loss of weight before the hepatitis, skin eruptions and mild peripheral neuritis were thought to be due wholly or in part to the arsenotherapy. There was evidence that two of the cases of AsJ were infected with IH. The differences in the two series indicate that AsJ gave rise to a more severe illness than IH in Cyprus and that individual cases might vary, but that otherwise as a group the clinical features of AsJ were not sufficiently dissimilar to differentiate it from IH.

The possible causes of AsJ are discussed. The evidence indicates that in Cyprus in the majority of cases the causative virus was introduced by the syringe used for injection. However, syringe transmission alone seems too simple an explanation to account for all the findings in this series. The racial and group differences noted in Cyprus and elsewhere suggest that there may be variable responses to infection and drug, that subjects under arsenical treatment may be more prone to contract infective jaundice by contact, that in some cases the AsJ may be IH caught intercurrently and that there may be a special risk of this, and that some may be cases of SH or AsJ spread by simple contact. The administration of arsenicals to a patient incubating a virus hepatitis may precipitate jaundice or aggravate the hepatitis. Arsenicals given after the onset of virus hepatitis may lead to a more severe illness, and administration too soon after recovery can lead to relapse which may be severe. It is wise to withhold arsenotherapy during AsJ and for at least three months after recovery from it.

#### CASE HISTORIES

*Case 1.*—Arsenical poisoning affecting the liver, bone marrow, kidneys, capillaries and skin and to a less extent the peripheral nerves, with a superadded virus hepatitis, possibly IH.

British Gunner, aged 29. Admitted to hospital on 5th May, 1942. Contracted syphilis early in 1941 and now at the end of his fourth course of arsenical treatment. The last injection was given on 24th April. Ten days previously he developed a mild irritant rash on his trunk and legs, and a week later bleeding from the gums and generalized bruising. He had noticed loss of weight and paraesthesia of legs and arms for several weeks before admission. He was referred from the Venereal Disease Treatment Centre, where heavy albuminuria had been found with red blood cells and casts in the urine.

On admission he was afebrile; nutrition was fair. There was no œdema. The gums looked normal but bled on massaging. There was a pink maculopapular eruption, confluent in places, on the sides of the trunk, especially the loins, and on the thighs, with dry scaling. On pinching, large bruises were readily produced under the skin. A tourniquet test produced a moderate crop of fine petechiæ. Nothing abnormal was discovered in the cardiovascular or respiratory systems. The blood pressure was



150/80. The liver was firmly and smoothly enlarged three fingers'-breadth below the right costal margin and was not tender. The spleen was enlarged two fingers'-breadth; it was firm and not tender (there was no history of malaria). The ankle jerks were absent, but there were otherwise no neurological abnormalities. The urine contained a moderate cloud of albumin and the deposit a few granular casts and red blood cells. The blood Kahn reaction was negative. The hæmoglobin measured 100 per cent. (Sahli). The red blood cells numbered 5.8 mil. per cu. mm. and the white cells 6,500 per cu. mm.; neutrophils 61 per cent.; lymphocytes 36 per cent.; eosinophils 1 per cent.; monocytes 2 per cent. The platelets numbered 75,000 per cu. mm. (direct method). The bleeding time was 4 minutes 20 seconds (Duke) and the clotting time 1 minute 45 seconds (Mas y Magro).

In hospital he remained afebrile and the bruising and gum bleeding soon stopped. The rash disappeared without treatment. The urine was free of red cells and casts by 22nd May and of albumin by 8th June. The blood pressure never became raised. No anæmia developed and the white blood cells remained normal. The platelets steadily dropped in number to 62,500 per cu. mm. on 12th May and to less than 50,000 on 29th May. They did not rise above this level until 15th June, when they numbered 62,000 per cu. mm.

On 8th June he became mildly jaundiced for the first time, without symptoms. His liver remained as before. The jaundice persisted but did not increase. No other abnormalities were noted. The splenic enlargement subsided and he appeared to put on weight. On 14th July military considerations necessitated his transfer to the mainland. A follow-up note stated that icterus of the conjunctivæ was still present on 18th August and that the liver was palpable and tender. By 11th October the liver size was considered to be within normal limits. There was no record of when the jaundice disappeared.

*Case 7.*—AsJ with hæmorrhagic manifestations aggravated by the last two doses of arsenical.

Cypriot Private, aged 23. Admitted on 11th November, 1942. Contracted syphilis in February, 1942, and now in the middle of his third course of arsenical treatment. He thought he had lost weight since starting anti-syphilitic treatment. His penultimate injection was on 31st October. A few hours later he experienced malaise, headache and nausea and thought that he subsequently became jaundiced. The jaundice persisted, but the other symptoms passed off in twenty-four hours. From 6th November he passed tarry black stools for some days. Immediately after the last injection on 7th November he felt dizzy and unwell, and vomited. These symptoms were followed by frontal headache, cramp-like epigastric pains and further vomiting. On one occasion he vomited a drachm of red blood. Most of these manifestations were severe for forty-eight hours before beginning to wear off. There was loss of appetite which lasted for three days. The jaundice was noticeably more marked on 8th November. He shivered and felt feverish every evening after the last injection of arsenical.

On admission he appeared ill and his temperature was 100.2° F., rising to 101° F. There was moderately deep jaundice. He was poorly nourished. There were no abnormal findings in the cardiovascular or nervous systems. There were scattered rhonchi in the lungs. The liver was enlarged three fingers'-breadth below the right costal margin, hard, smooth and mildly tender. The urine contained much bile and a faint cloud of albumin, but no abnormal deposit. The blood Kahn reaction was negative. Blood films contained no malarial parasites. On 13th November the hæmoglobin

measured 115 per cent. The red blood cells numbered 4.5 mil. per cu. mm. and the white cells 4,000 per cu. mm.; neutrophils 66 per cent.; lymphocytes 33 per cent.; eosinophils 1 per cent. The platelets numbered 205,000 per cu. mm. The bleeding time was two and a half minutes and the clotting time twelve minutes. The tourniquet test was negative.

The jaundice deepened and his temperature was variably raised to a maximum of 102.4° F. until 15th November, when it returned to normal. The urine contained albumin until 30th November. A few red cells and granular casts and numerous white cells were found on occasion in the urinary deposit. By 30th November he felt well but remained deeply jaundiced. On 5th December the white blood cells numbered 14,800 per cu. mm.; neutrophils 50 per cent.; lymphocytes 47 per cent.; eosinophils 2 per cent.; basophils 1 per cent. The platelets numbered 350,000 per cu. mm. The bleeding and clotting times were almost unchanged. There was mild intermittent hepatic tenderness until 19th December. By this time the jaundice was fading and the liver could no longer be felt. The urine contained urobilinogen in abnormal quantities until 10th January, 1943. The jaundice had disappeared by 12th February. He appeared to put on weight in hospital.

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# DESERT RESCUE: THE PARACHUTE MEDICAL TEAM

BY

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## INTRODUCTION

PARADOXICALLY enough, in the Middle East, as part of the desert search and rescue organization, the Army travel by air to the objective—*e.g.*, a crashed aircraft—and then, together with their patients, are rescued by the Royal Air Force, who arrive by the land route.

The Parachute Medical Team, staffed by personnel of 16th Independent Parachute Brigade Group, is thought to be the only team of its kind ever to be formed in the British Army. The French Army have a similar team operating in the Sahara Desert, and it was used in 1952 when a *Hermes* made a forced landing there after running out of fuel. The United States Army has a very elaborate team.

The Royal Air Force maintains a world-wide search and rescue organization which includes ground, mountain and sea rescue units, by which medical aid can be rushed to the injured within a reasonably short time. The Middle East presents a difficult problem as most flying, both civilian and service, is done over desert and very sparsely populated land which will not support life, even temporarily. The few roads are of indifferent quality and the going for wheeled vehicles is difficult. Delay in these regions antagonistic to life may well be fatal to the unattended, waterless and exposed casualty. The Parachute Medical Team exists to provide aid during the interval between the sighting of the wreck from the air and the arrival of the ground rescue team, which may have to toil through miles of soft sand and other difficulties.

## BEGINNINGS

The Royal Air Force appreciated the uses of such a unit to augment their existing desert rescue organization. Thus in 1949 two parachute teams were formed, based on Aden and Fayid respectively, staffed entirely by R.A.F. personnel, including nursing sisters. These teams were eventually discontinued because of training difficulties and replacement of trained parachutists.

In the spring of 1952 the Royal Air Force requested that a parachute medical team be made available on call to them from 16th Independent Parachute Brigade Group and this was readily agreed to. The original team, formed by a Parachute Field Ambulance, consisted of one medical officer and three nursing orderlies, each carrying a parachutist's kitbag, with further supplies in two C.L.E. containers slung under the aircraft for dropping. Equipment tables had to be worked out from first principles, and it was of interest, at a later date when details of the former R.A.F. teams' equipment became available, to discover



**PLATE 1. THE COMPLETE TEAM: MEDICAL OFFICER, CORPORAL AND THREE PRIVATES, R.A.M.C.; CORPORAL AND TWO SIGNALMEN, R. SIGNALS; AND SERGEANT DESPATCHER, R.A.F.**



**PLATE 2. THE MEDICAL ELEMENT OF THE TEAM CARRYING EQUIPMENT CONTAINERS**

how similar the teams were. The Army team was lighter, as the R.A.F. carried more shelter, a greater variety of drugs, and even an airborne operating table.

#### THE PRESENT TEAM

To be effective a parachute medical team must be able to go into action very rapidly, be able to save life and give adequate first aid. The present team is a compromise between speed on the one hand, which means simplicity, lightness, and the involvement of as few people as possible, and on the other hand the need to have sufficient to deal with all foreseeable injuries to those in the crashed aircraft, whether a single-seater fighter or a crashed airliner.

The composition of the team is as follows (see Plates 1 and 2) :

R.A.M.C.	...	Medical officer	...	1
		Corporal	)	
		3 Privates	) ...	4
Royal Signals	...	Corporal	)	
		2 Signalmen	) ...	3
Total				8

Equipment is carried in seven parachutists' equipment containers (carried on the man) and in four C.L.E. containers (3 medical, 1 signals) (see Plate 3). The medical officer performs the duties of stick commander and is responsible for all the team. An R.A.F. despatcher assists him in the selection of the dropping zone.

The mechanism of wireless is not particularly well suited to the insults of parachuting, and to ensure efficient communications all equipment is duplicated. The second signalman in the team is, in fact, only included because a man is the safest vehicle for parachuting wireless equipment.

#### EQUIPMENT

The cases most likely to require urgent treatment are those of burns, fractures, lacerations, exposure and shock. The essential basic items to deal with these are fluids, morphine, splints, antibiotics, dressings, shelter and food. A require-



PLATE 3. A GENERAL VIEW OF THE CONTENTS OF THE THREE C.L.E. CONTAINERS

ment for at least minor surgery must also be met. All ranks in the team each carry two filled water-bottles, and distributed throughout the rest of the equipment are a further seven water-bottles and two  $4\frac{1}{2}$ -gallon water jerricans. Each man also carries a bottle of Dextran, and a padded pannier in one of the containers carries a further six bottles of Dextran and glucose saline (see Plate 3). Morphine is carried in the form of tubonics. Three Thomas splints, supplies of Krämer wire, and plaster of Paris are also carried. Any painful fractures, lacerations, etc., would be immobilized in plaster of Paris or a combination of splints and plaster (*e.g.*, the Tobruk splint) because of the necessarily rough going in the desert on the return journey.

A modified surgeon's roll is carried and also chloroform, pentothal and local anæsthetic.

One of the greatest problems in the care of the injured and ill in the desert is the provision of shade. The team carries only one bivouac, but it requires twelve parachutes to bring it and its equipment down and these, together with the wreckage and empty containers, would supply ample and efficient cover. The three stretchers in the equipment would be used as beds for the worst cases. As will be seen later, once the team is on the ground it is in constant wireless communication with a patrolling aircraft above it, and requests for further reinforcements can be quickly sent to base.

Each member of the team carries a 24-hour ration pack and in the C.L.E. containers are two ten-man "compo" ration packs. Each man has a "Tommy cooker," and a stove and fuel are dropped in one of the containers.

#### PROCEDURE

The team is normally on call by H.Q., R.A.F. Group, through H.Q., 16th Independent Parachute Brigade Group, and during periods of intensive flying, or when a V.V.I.P. (*e.g.*, our Colonel-in-Chief in 1953) flight is taking place, it lives at the take-off airfield. The R.A.F. maintain a stand-by Valetta aircraft fitted out for the parachuting role and with the requisite container beams, etc., at this airfield.

On call forward the medical personnel in the team with their equipment move off in unit (Parachute Field Ambulance) transport, collect the Signals personnel, and proceed to the take-off airfield one hour distant. There they are met by an A.C.O. (airfield control officer) with the parachutes, and he has already arranged for the R.A.F. armourers to be ready to "bomb-up" the C.L.E. containers. The aircraft is ready to take off within half an hour of the arrival of the team.

The aircraft flies at optimum searching height until the accident is sighted, when it flies in low to find out as much as possible about the crash—*e.g.*, if there are any survivors—and to select (the R.A.F. parachute jumping instructor and the medical officer) the most suitable dropping zone. At this stage a smoke canister is thrown out and this gives information about the ground wind speed and direction.

The medical officer and a nursing orderly jump first and examine the position



on the ground. If there are any injured in need of help, a green Very cartridge is fired by the nursing orderly and the remainder of the team jump. On the other hand, if medical aid is not required, a red Very light is fired and the containers only are dropped in order to supply those on the ground with food and water. In either case the aircraft continues to orbit the area until relieved by another aircraft, and so on until the arrival of the R.A.F. ground rescue team. The aircraft also relays any demands for re-supply.

#### SUMMARY

The Army Parachute Medical Team is an 'example of inter-service co-operation. It is formed by personnel and equipment from 16th Independent Parachute Brigade Group (23rd Parachute Field Ambulance and 16th Independent Parachute Brigade Group Signal Squadron), and is one of the units in the Royal Air Force desert rescue organization.

The function of the team is to save life during that possibly critical period between the location of a desert air crash and the time the R.A.F. ground rescue team arrives. It is always at three hours' notice except during periods of intensive flying, when it is resident at the take-off airfield. It consists of a medical officer, four other ranks, R.A.M.C., and three other ranks, Royal Corps of Signals. Equipment is carried on the man in containers, equipment, parachutist and in C.L.E. containers dropped by the pilot of the aircraft. The equipment includes medical supplies, food, water, and wireless.

The team is equipped to deal with shock, exposure, burns and fractures and to do minor surgery. It relies upon an R.A.F. ground rescue team to extricate its patients and itself from the desert.

Although devised to serve crashed aircraft, the Parachute Medical Team can equally well be used for any distant, inaccessible desert accident where the country is inhospitable, time is precious and roads are bad and few.

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# THE WOUNDING AND KILLING POWER OF SMALL-ARMS FIRE IN JUNGLE OPERATIONS

BY

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## INTRODUCTION

WITH guerilla warfare in dense jungle such as is characteristic of the Anti-Terrorist Operations in Malaya, it is not an easy problem to estimate accurately the full extent of enemy casualties. This is because the wounded bandit, unless killed outright, is rarely seen again because, even if gravely wounded, he is usually carried off by his comrades, and the recovery of the bodies of those dying subsequently is relatively unusual. Apart from the consequent difficulty in estimating terrorists eliminated, this tends also to affect the confidence which troops, new to this type of warfare, have in their weapons, because unless a bandit is known to be killed he must be assumed to have escaped even if wounded.

It is therefore of some importance to study the stopping power and lethality of various weapons available and to be able to calculate, with some reasonable measure of accuracy, the survival chances of the enemy, known to be wounded, but not seen again. This can be done by examining the anatomical and physiological features of missile wound casualties, by analysing such statistics as are available about our own wounded under similar circumstances, and by making a calculated estimation from them of the survival chances of enemy wounded.

## STATISTICS AVAILABLE

Unfortunately statistics available from the Malayan operations are less complete than would be liked and it is necessary to point out their limitations. The practice of reporting missile wound casualties in summary form to Medical Directorate, Far East Land Forces, did not begin until 1950, prior to which no detailed figures are available in FARELF. Details of casualties are known only for those who survived to reach hospital alive, and even this information is often incomplete in that evidence as to range is exceptional and of calibre is available in about only half the bullet wounds. No attempt has been made to distinguish between wounds received by enemy action and those received accidentally because the circumstances, *i.e.*, close range, were similar and the results the same. Unfortunately very few details are known about the wounds of those killed outright or dying before arrival at hospital. The following tables summarize available data from military hospitals in Malaya :

TABLE I.—TYPE OF MISSILE : ANALYSIS OF 845 CASES ALIVE ON ADMISSION TO HOSPITAL

Type of missile	Number of cases	Fatal
Rifle bullets (.303) ... ..	260	21
Carbine bullets ... ..	170	9
Unspecified or miscellaneous bullets ...	240	17
Shotgun pellets ... ..	46	5
Explosive fragments ... ..	129	5

TABLE II.—MULTIPLE WOUNDS : ANALYSIS OF 99 CASES ALIVE ON ADMISSION

Type of missile	Number of cases	Fatal
Multiple rifle ... ..	36	6
Multiple carbine ... ..	35	4
Multiple unspecified bullet ... ..	38	2

All shotgun and nearly all grenade wounds were multiple and these have not been included in Table II.

TABLE III.—REGIONAL LOCATION OF WOUNDS : ANALYSIS OF A SERIES OF 761 WOUNDS

Location of wounds	Cases	Fatal
Head ... ..	14	7
Spine ... ..	7	4
Chest ... ..	61	10
Abdomen and Thoraco-abdominal ...	68	21
Face and neck ... ..	29	2
Limbs (major wounds) ... ..	582	10

Fatal cases with multiple wounds are shown only against what was considered to be the principal cause of death. Thoraco-abdominal wounds have been included with abdominal wounds. Suicides have been omitted. Minor soft tissue wounds have been included.

TABLE IV.—ANALYSIS OF 53 CASES BROUGHT IN DEAD

Site of lethal wounds	Number
Head ... ..	14
Chest ... ..	24
Abdomen ... ..	14
Limbs ... ..	1

Of these, 14 had multiple wounds, in which case the main lethal wound only is recorded. This small series comprises mainly British fatalities brought in dead to military hospitals during 1952 and 1953. Prior to this, no details are available in FARELF. Casualties brought in dead to military hospitals have been mainly British troops, it being more usual for others to be buried directly under unit arrangements.

#### STOPPING POWER OF MISSILES

The stopping power of a missile may be either absolute or delayed. Absolute stopping occurs only when a structure is hit which is vitally concerned with life or locomotion and the casualty falls at once, either killed outright or incapable of further locomotion. Absolute stopping power, then, depends essentially on the structure hit and is independent of the nature and size of the missile. Examples of this are most penetrating wounds of the brain, wounds of the spine or of the main nerve to the lower limb, wounds causing a fracture of the femur or

of both bones of the lower leg or causing the loss of the lower limb. Such wounds will always cause immediate stopping. Delayed or reactionary stopping is a much more complicated phenomenon as it depends on the physiological response to a missile injury not of itself immediately fatal or immobilizing. This is extremely variable because of the complicated physiological and psychological responses which may occur under conditions of extreme stress, profoundly to modify the so-called normal response. Thus one man may fall into a dead faint after a minor wound while another may perform incredible feats after being gravely wounded, as in the case of a Malayan bandit, partly eviscerated, who ran over 200 yards trailing intestine and then survived to be successfully operated on.

The dual autonomic control of body activity by the antagonistically acting sympathetic and parasympathetic systems is co-ordinated at hypothalamic level with probably over-all direction from higher levels. In ordinary emergencies the sympathetic system predominates, with its characteristic response to fear, rage and similar emotions, but in extreme emergencies, such as acute peril or actual injury, either system may take control. If the parasympathetic system predominates, the subject faints and may pass into a condition of acute temporary shock. This vasovagal syndrome is the normal response to a severe injury and often to a minor one, and when it occurs the stopping power of the injury is, for the time, absolute. However, under conditions of intense emotional stress, although both systems are stimulated, sympathetic control may predominate and no vasovagal response occurs. This is seen in the phenomenon of running amok, in fanaticism and in some maniac states. It may also occur in the heat of battle provided the stimulus is strong enough, and it appears to have nothing to do with training, discipline or morale, but depends on the individual's emotional make-up. When fear amounts to terror a similar response may occur and the impulse to escape may enable unbelievable feats to be performed. Provided the emotional stimulus is maintained, such individuals may sometimes carry on until weakness from blood loss makes further activity impossible. When reaction eventually sets in in these cases the response is likely to be severe.

For military purposes, in terms of stopping power, the reaction to wounding may be said to be so unpredictable, particularly when dealing with an enemy stimulated emotionally to the point of fanaticism, that the only sure way to stop him is to hit him in one of the vital spots already mentioned so that he is either killed outright or rendered incapable of further locomotion. The more hits obtained and the more damaging the missile, the more likely is this to be effected.

#### LETHALITY OF MISSILE WOUNDS

A missile may kill in one of two ways. Either it kills outright by seriously damaging a vital structure such as the brain stem or the heart or great vessels, or else it kills by damaging a structure not in itself essentially vital, but which sets up a train of events which, unless interrupted by effective surgical intervention,

sooner or later becomes incompatible with life. Of these the most important is hæmorrhage, then comes shock, and finally infection and toxæmia.

Theoretically all wounds not immediately fatal are savable by surgery, but practical considerations make this, of course, impossible. The object of military surgery is to salvage as many of this group as possible by early operation before the consequences of the damage sustained have become irreversible. Thus the lethality of missile wounds not immediately fatal will depend very largely on the nature of the military operations and on the efficiency of the medical services attending them. The Malayan terrorist, with his almost negligible surgical facilities, may reasonably be expected to suffer a considerably higher wound mortality than that occurring among our own troops.

As regards relative lethality of small-arms missiles, by far the most important factor is the part struck and, provided a vital structure is hit, the size and velocity of the missile are relatively unimportant and a small grenade fragment can be just as deadly as a rifle bullet. But if the wound is not immediately or rapidly fatal, then the bigger the missile and the greater its velocity, the greater will be the chance of producing damage which will be irreversible by the time the casualty reaches a surgical centre, and at the same time the greater will be its stopping power. My personal experience with the surgery of missile wounds has been that the .303 rifle bullet does the most damage, followed by carbine bullets. The .38 revolver bullet often does relatively little damage, and my experience in a casualty clearing station during the Burma campaign with the Japanese small calibre high velocity rifle was that it was far less damaging than our own rifle bullet. Short range wounds tend to be more damaging than medium range, and a ricochet bullet which had become unstable can be the most damaging of the lot. Explosive fragments are unpredictable.

The figures given in Tables I and IV, although they give no indication of stopping power, show the incidence of fatal wounds with various types of missile where this is known for 1950-1953, and also the regional distribution of fatal wounds. The results are as might be expected, and surgical experience with gunshot wounds in Malaya merely confirms what appears to be self-evident—i.e., that the midline of the head and trunk are the regions to shoot at, and that as many hits as possible with a large bore high or medium velocity weapon at short range is the surest way of stopping and killing an enemy. Although the high velocity missile appears to have greater stopping power, a proportion of these are clean through and through flesh wounds which, with an enemy denied modern surgical facilities, are often less serious than the retained missile of the low velocity weapon, which may be expected to cause severe prolonged disability and a higher late mortality from wound infection.

#### ESTIMATE OF TERRORIST WOUND MORTALITY

It is possible, from an analysis of our own casualties of which, since 1950, fairly full details are available, to estimate the approximate chances of survival following a missile wound under local conditions both with and without modern

surgical facilities. To apply the resulting percentage to bandit casualties it is only necessary to postulate that the wounds they receive are no less severe than the wounds they inflict on us, and that the general proportion of wounded to killed outright holds.

It is not necessary to distinguish between wounds received from enemy action and those received otherwise as it is the wound itself which is important, not the circumstances under which it is sustained.

TABLE V.—ANALYSIS OF A SERIES OF 592 CASUALTIES FROM ENEMY ACTION

	Number	Percentage
Total casualties ... ..	592	
Reported killed in action ... ..	171	28.9% of total
Reported died of wounds ... ..	32	5.4% of total, 7.6% of wounded
(a) During evacuation ... ..	15	2.5% of total, 3.6% of wounded
(b) In hospital ... ..	17	4% of wounded

TABLE VI.—ANALYSIS OF 929 WOUNDED ADMITTED TO MILITARY HOSPITALS IN MALAYA, 1950-53

Site of wound	Results with surgery		Estimated results without surgery and hospital facilities			
	Number of cases	Died in hospital	Would have died without surgery	Would probably have died without surgery	May have died without surgery	Unlikely to have died
Head ... ..	14	7	11	2	1	—
Spine ... ..	7	4	7	—	—	—
Maxillofacial ... ..	22	2	10	4	4	4
Chest ... ..	61	10	32	8	11	10
Abdomen (including thoracoabdominal)	68	21	58	5	2	3
Bone and joint ... ..	271	7	55	57	44	115
Major soft tissue ... ..	319	3	3	30*	30*	256
Minor soft tissue ... ..	167	—	—	—	—	167
Total ... ..	929	54	176	106	92	555
Percentage ... ..		5.8	18.9	11.4	10	58.6

\* The prognosis of soft tissue wounds without surgery or hospital treatment is extremely difficult to assess because the effect of sepsis in the jungle, and without antibiotics or sulphonamides, is unknown. In any case it is likely to vary considerably with the nutritional condition and general fitness of the terrorist which is known often to be low. I have therefore assumed that 10 per cent. of untreated major soft tissue wounds would probably die and another 10 per cent. may die. This may well be an underestimate.

It will be seen from Table V that under the best available conditions, that is with our own troops, approximately 29 per cent. of casualties are killed in action during engagement in the jungle in Malaya. Of those wounded, approximately 7.6 per cent. subsequently die, of whom approximately half die before reaching hospital. With accidental wounds a higher proportion reach hospital alive. The mortality after admission to hospital is 5.8 per cent. for all wounds (figure for 1950-1953 inclusive).

The estimated survival chances given in Table VI have been calculated by going carefully through the case reports of our own wounded and trying to estimate what would have happened to each case without the benefit of hospital treatment and modern surgery. From this the following figures have been obtained :

Certain to die	...	...	...	...	approx. 19 per cent.
Likely to die (chance over 50 per cent.)	...	..	11	..	..
May die (chance under 50 per cent. but over 20 per cent.)	...	...	...	..	10 .. ..
Unlikely to die (chance under 20 per cent.)	..	59	..	..	

The group "Certain to die" is made up of those wounded who did die plus those saved solely by modern surgery. The chances here of survival without operation would have been very small indeed, certainly under 1 per cent. The remaining wounds, though not intrinsically fatal, carried a risk of death from hæmorrhage, shock or infection which varied with their severity. The risk for infection would be specially serious where bone was involved, as occurred in 29 per cent. of all wounded, remembering that no antibiotics are available to jungle terrorists and only rarely sulphonamides in very limited amounts. Without full hospital facilities and modern methods of controlling infection, the mortality to be expected in these groups may well be of the following order :

Likely to die	...	...	...	About 75 per cent.
May die	...	...	...	.. 30 to 40 per cent.
Unlikely to die	...	...	...	.. 5 to 15 .. ..

Conditions of severe malnutrition would appreciably increase the mortality from infection in otherwise less serious wounds and raise the estimate made above. With survivors, the disability with many would be prolonged, unfitting them for active terrorist participation for a considerable time.

Combining the above figures, it would seem that the over-all chances of survival of a wounded bandit in the jungle are little better than two out of three and are possibly less than 50 per cent.

#### CONCLUSION

The factors involved in small-arms stopping power and lethality have been reviewed with special reference to conditions in the Malayan jungle. A study of statistical data available has revealed no new factors and confirmed views long held. An estimate of the chances of survival, after wounding in the jungle without hospital and surgical facilities, has been made and conclusions of some interest have been drawn.

I wish to thank Brigadier D. Bluett, *O.B.E.*, Director of Medical Services, Far East Land Forces, for permission to send this paper for publication.

## ON THE NATURE OF HYPNOSIS

AN ACCOUNT OF A MEETING OF THE PSYCHIATRIC GROUP OF THE BRITISH  
MEDICAL ASSOCIATION

BY

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ON Thursday, 8th January, 1953, the Psychological Medicine Group of the British Medical Association met at B.M.A. House, Tavistock Square, with Dr. H. B. Craigie in the chair, to discuss "The uses, limitations, and dangers of Hypnotism."

The discussion was opened by Dr. E. A. Bennet, who will be remembered by many officers of the Corps (both past and present) as Consultant in Psychiatry in India and to many newly joined doctors at No. 1 Depot in the early days of the war.

Dr. Bennet opened by saying that in many ways the position of the medical profession, and the lay public, as regards hypnotism had changed little since the days of Chariot (1892) and Mesmer (1830). He begged leave to differ from the B.M.A. in its recent definition of hypnotism (for purposes of the Bill at present before Parliament to control stage hypnotism), this definition being: "The use of suggestion with the intention of bringing about an altered state of consciousness involving a surrender by the patient of his normal powers of control."

He agreed that it was largely a matter of terminology, but suggested that surely hypnotism was a means of reaching the unconscious rather than "use of suggestion, etc." Continuing, he stated that in order to produce hypnosis in a patient one must first establish *rapport* with the subject, and he emphasized that by *rapport* he did not in any way imply "transference" (for those unversed in these rather exclusively psychiatric terms, *rapport* is "collaboration between patient and doctor," whereas transference means "that feeling that springs up in a patient towards the doctor in a psycho-analysis" and may be positive or negative). He recommended the use of hypnosis when it was capable of showing immediate results as in fugue states and amnesias, but even here, in most cases, it should be followed up with analysis. He considered it had also a part to play in the treatment of impotence and enuresis.

Referring to the criticisms of a recent committee, who stated that the results were not permanent, he considered that this was possibly due to bad selection of cases, as in his own series he had watched for relapses over many years without result.

With regard to technique and "preparation" for hypnosis, some stress the



necessity for very careful build-up and equally meticulous technique, but again he begged to differ as he considered technique of absolutely no importance and never indulged in any over-lengthy approach to the problem.

Dr. Bennet summed up by saying that hypnosis should only be used in a small group of carefully selected cases for short periods and generally required a "follow up" analysis. The chief danger in unsuitable cases, particularly potentially psychotic patients, was the flooding of the patient's consciousness with unconscious material, which he was unable to accept, with consequent undesirable results.

A further danger—and this might happen with non-psychotic patients—was that the restriction of consciousness which occurs in hypnosis might give an outlet to tendencies at variance with the patient's conscious moral standards. Hypnotism should be practised only by those whose training and experience enabled them to make a psychiatric diagnosis and whose judgment in selecting suitable patients for this treatment was sound.

Professor Alexander Kennedy next spoke. He did not claim to be either an expert in, or a particular enthusiast for, hypnosis. Nevertheless, he considered it should be part of the background of every psychiatrist. Referring to the present attitude of the Government to stage hypnosis, he stated that in Prussia in 1819 a law was passed limiting the use of hypnosis to physicians, who had to keep accurate details of the number and duration of hypnotic sessions in each individual case: it was of interest that this law, like many others against hypnosis, was never repealed; it merely became a dead letter.

From a scientific point of view our knowledge of the nature of hypnosis was very incomplete; the definition "The use of suggestion, etc." as proposed by the B.M.A. was purely descriptive. Hypnosis was not, as hitherto believed, related in any way to sleep, the electro-encephalogram (E.E.G.) in sleep being quite dissimilar to that in hypnosis. In work in which he was interested, in the production of "experimental neurosis" in humans, the E.E.G. in "experimental hysteria" was closely akin to that of hypnosis. Hypnosis appears to be able to alter the "psychosomatic link." There had been many attempts to explain the phenomena of hypnosis, and hypnotism seemed often to attract explanations in terms of current theory. Just as it was magnetism in Mesmer's time, so at the present time extra-sensory perception was being invoked.

With regard to the lay attitude to hypnosis it was obviously impossible to be neutral; the essential thing to the uninitiated was that hypnosis was striking and therefore attention-compelling.

From the point of view of the final-year medical student, with whom so many of those at the meeting were concerned, a good knowledge of hypnosis was, in his view, a very fine training in the objective attitude towards neurosis. For those who wished to read more about it he recommended strongly the fine textbooks of the middle of the last century rather than the products of the more modern Medical Society of Hypnotists. Hypnosis he considered a practice for extraverts, introverts being essentially unsuited to apply it. He also considered hypnosis to be the basis of most abreactive techniques and the most

controllable of all. He considered the main complications of hypnosis, particularly in the hands of lay hypnotists, to be the relapse into a post-hypnotic state of various members, mainly female, of the working classes.

With regard to the medical aspects, he did not consider hypnosis to be nearly as dangerous as many of the "cranioclastic" operations of modern physical methods of treatment.

The meeting was then thrown open to discussion, and in the ensuing dissertations it was obvious to the writer that the number of varying opinions as to the uses, limitations and dangers of hypnosis was roughly proportioned to the number of members present (or at least to the number who were bold enough to air their views). On the one hand, we had Dr. Clifford Scott stressing the great value of hypnosis in forward military psychiatry : he envisaged the general duty medical officer at C.C.S. level in future wars having a team of trained "medical ancillaries" under him, applying hypnosis to the acute neuroses. On the other hand, another member stated it was his considered opinion that hypnosis should only be used by a qualified medical psycho-analyst who himself had had a really effective training analysis (he did not say who was to decide whether the said training was effective or not !).

Dr. J. R. Rees said that it would be interesting to learn Dr. Kennedy's objections to lay hypnotists. He understood the objection to be not only to stage performances but to the little clinics afterwards which might be formed around the lay hypnotist.

Professor Kennedy replied that he thought it would be wise to suppress such demonstrations, but largely on the grounds of good taste. It was possibly more of a public matter than specifically a psychiatric one. There were, however, dangers arising from what might be called the side activities of the mesmerists, and these might be greater than those arising from their public performances. One of the difficulties was that the public was apt to say, "These people can do it ; can you ?" If doctors combined to suppress something which apparently they could not make use of themselves they looked rather feeble in the eyes of the public. Braid, Elliotson and Esdaile had been persecuted by their colleagues because they investigated hypnosis.

Another speaker deplored the attempt of the Government, aided and abetted by the B.M.A., to control and restrict the lay public still further : he said, "We made fools of ourselves over Sir Herbert Barker ; don't let us repeat this over Ralph Slater."

This again was "shot down" by Dr. Doris Odlum, who objected to the use of hypnosis, particularly by the lay public, for monetary gain and not solely in the interests of the patient (but again where can the dividing line be drawn ?). Yet another doctor said, "Suppress public exhibitions of hypnotism, but explain why you are doing so." (He did not say to whom and by what means.)

Due to press of time and an impending function in the building, the meeting broke up without any general decision being taken.

The writer apologizes, in advance, for any inaccuracies that may have occurred in any statements attributed to the many speakers ; he is sure that

any member present will agree that the atmosphere at the meeting, although most stimulating, was not conducive to accurate note-taking.

My thanks are due to the Chairman of the Committee of the Psychological Medicine Group, B.M.A., for permission to attend the meeting, and to Major-General R. Murphy, *C.B.*, *C.B.E.*, M.B., Q.H.S., D.D.M.S., Southern Command, for permission to forward this article for publication. It is hoped that it may stimulate further discussion on the obviously unsolved problem, "Of the Nature of Hypnosis."

[The courtesy of the Secretary of the British Medical Association and of the Editor of the *British Medical Journal*, in allowing this note to be printed, is acknowledged.]

# THE VISIT OF SIR HARRY PLATT TO THE BRITISH MILITARY HOSPITAL, CYPRUS

BY

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AND

Major A. A. GREGORY DEAN

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DURING the last ten days of October, 1953, Sir Harry Platt visited Cyprus as part of a tour of the Middle and Near East arranged under the auspices of the British Council.

By a fortunate coincidence, Sir Harry was staying at the same hotel as the D.M.S., M.E.L.F., who was also visiting Cyprus at that time, and they literally walked into each other in the foyer of the Ledra Palace Hotel.

At the invitation of Major-General W. A. D. Drummond, Sir Harry visited the B.M.H. on the following evening (23rd October, 1953) and made a short informal tour of the hospital. Sir Harry looked in at the reception department and wards, and later saw winter training lectures in progress, but could not with advantage at such a time make detailed examination of our orthopædic cases, so a further and more formal visit was arranged. Sir Harry did, however, visit the Officers' Mess, where he met the medical officers and proved to be most entertaining.

Sir Harry gave a formal lecture at the British Institute on the following day, which was well attended by representatives of the medical profession throughout the island. He spoke on "Low Back Pain" not only as an authority on the subject, but also as a late sufferer.

Two days later, Sir Harry made his second visit to the B.M.H., when he was escorted round the surgical department and was shown the cases in the orthopædic ward. He gave a brilliant exposition of the cases demonstrated which was of the greatest value and was most highly appreciated by all the staff.

The following are brief histories of the cases presented, with illustrations :

CASE 1.—Male, U.K.-based civilian, aged 44. Compound comminuted fracture of right olecranon sustained while travelling in a car when his elbow, outside the driving window, was hit by a passing vehicle. Wound toilet was carried out. Excision of fragmented olecranon with reconstruction of triceps tendon was performed six days later. Patient had been on physiotherapy as from date of operation and had had sutures removed two days before being demonstrated.

*Note.*—Sir Harry forecast a good result and this is proved by photographs taken three months after injury (Figs. 1, 2, 6 and 7).

CASE 2.—Male, U.K.-based civilian, aged 20. Multiple injuries, including simple fracture of right humerus and compound comminuted fracture of right tibia and fibula. The humerus required open reduction and plating in order

that apposition of the bone ends be maintained while the patient was nursed in bed for his other injuries (Fig. 3).

*Authors' Note.*—Eight weeks after plating, and while still a bed patient, the humerus was refractured at the old site, partially tearing the plate and screws from their position. This refracture was an accidental injury caused by the patient. Deformity and reduced function now exist—a disappointing result.

CASE 3.—Male, British (sergeant, R.A.). History of three previous attacks of low back pain treated conservatively. Radiological changes present, muscle wasting and persistent pain in right leg. Straight leg raising on the left side only ten degrees. Sensory changes marked. Examined by Sir Harry, who considered that this was a true case of prolapsed nucleus pulposus. In view of the patient's rank, age and mental outlook, he advised laminectomy.

*Authors' Note.*—Patient evacuated to the U.K. Laminectomy performed ; now doing well and quite pain-free.

CASE 4.—Gunner, aged 19. Admitted with low back pain following a "strain" of his back at gun drill. On examination, there was no deformity of the lumbar spine, no muscle wasting in thighs or legs and no difficulty in straight leg raising. X-ray examination (Fig. 4) showed a bilateral accessory sacro-iliac joint.

*Sir Harry's Comment.*—Patient pain-free after short rest in bed. Advise physiotherapy. If, in future, a recurrence becomes evident which does not respond to conservative treatment, arthrodeses of the supernumerary joints should be considered. Advised down-grading to P3 L3.

CASE 5.—A sapper, aged 20, who had been engaged on demolition work in the earthquake area, was injured by a large piece of falling masonry causing a compound fracture of his right tibia and fibula (Fig. 5). The fracture was unstable, a large butterfly fragment was present, so open reduction and plating were carried out. The plate was placed on the medial aspect of the tibia so as not to interfere with the periosteal hinge.

*Sir Harry's Comment.*—Correct decision, excellent reduction. Plate should be removed in one year's time, full function to be expected.

At the conclusion of this teaching round, Sir Harry visited the operating theatre, the physiotherapy department and the maternity block.

He made two comments which are well worthy of note :

1. Regarding physiotherapy, he stated that he viewed with concern the falling off of massage as a form of treatment and strongly advocated a boost to re-establish massage, especially in post-operative orthopædic cases.

2. That the care given here to nursing mothers and their infants, despite difficulties and staff problems, was as good as any given in the U.K., outside the most modern teaching centres.

On Thursday evening Sir Harry dined at the R.A.M.C. Officers' Mess. In reply to a speech of welcome by the Commanding Officer, who stressed the value to the Corps of a visit such as had been made, Sir Harry replied in most polished vein and paid tribute to traditional Mess custom and ceremony, which



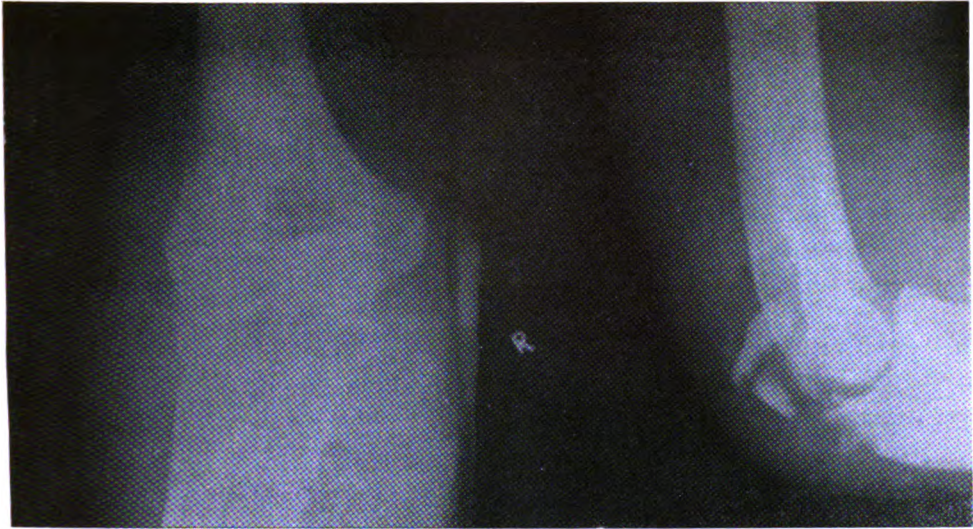


FIG. 1. COMPOUND COMMUNUTED FRACTURE OF OLECRANON BEFORE OPERATION

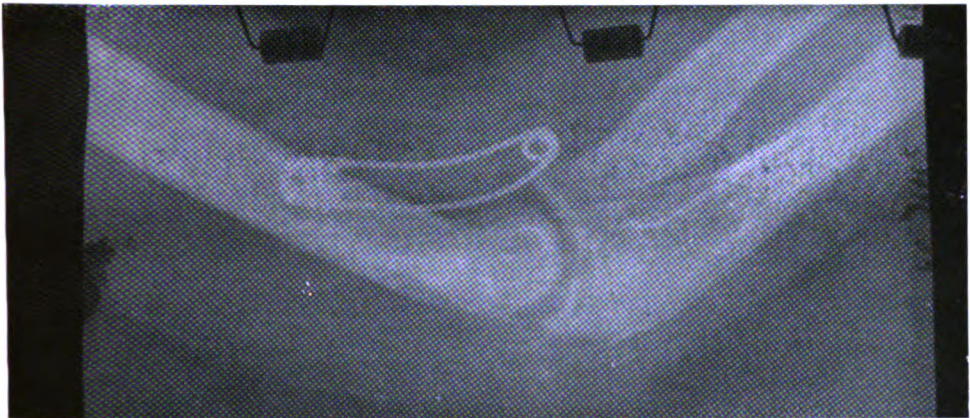


FIG. 2. AFTER EXCISION OF FRAGMENTS

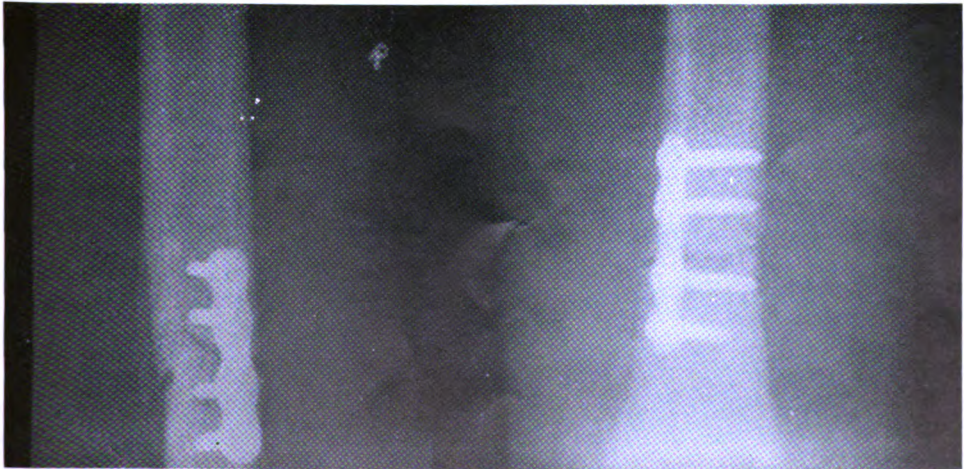


FIG. 3. CASE 2 AFTER PLATING. A LARGE BELLY OF BRACHIALIS WAS FOUND BETWEEN THE FRAGMENTS, THUS PREVENTING CLOSED REDUCTION

*Facing page 44*





FIG. 4. CASE OF LOW BACK PAIN : NOTE ACCESSORY SACROILIAC JOINTS

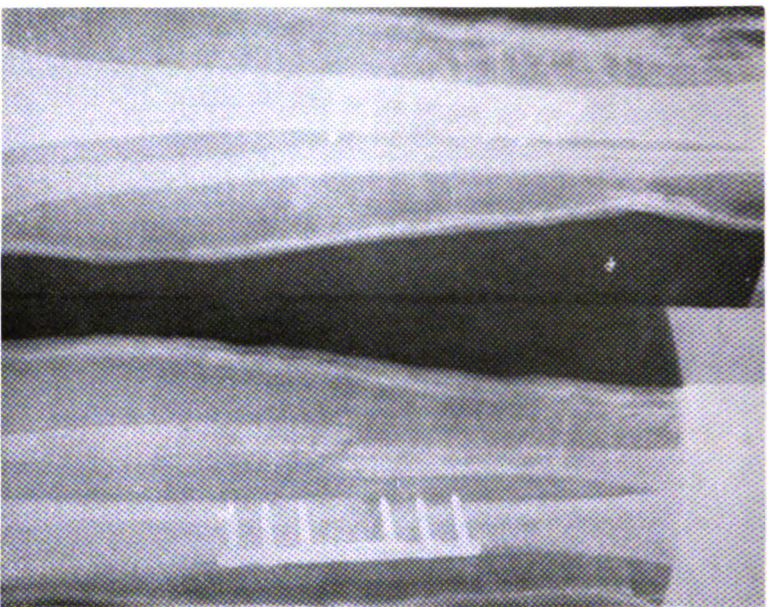


FIG. 5. CASE 5 AFTER OPEN REDUCTION AND PLATING

he considered of great importance in present times. Mr. Arnold Rose, F.R.C.S., an ex-officer of the Corps, now the leading surgeon on the island, was also present.

The visit of Sir Harry Platt to the B.M.H. was undoubtedly of great value not only by virtue of the teaching round and the opportunity afforded to medical officers, both Regular and National Service, of meeting him, but it also gave Sir Harry an opportunity of seeing for himself the quality of the work done and the responsibilities of the R.A.M.C. in a small medical unit overseas.



FIG. 6

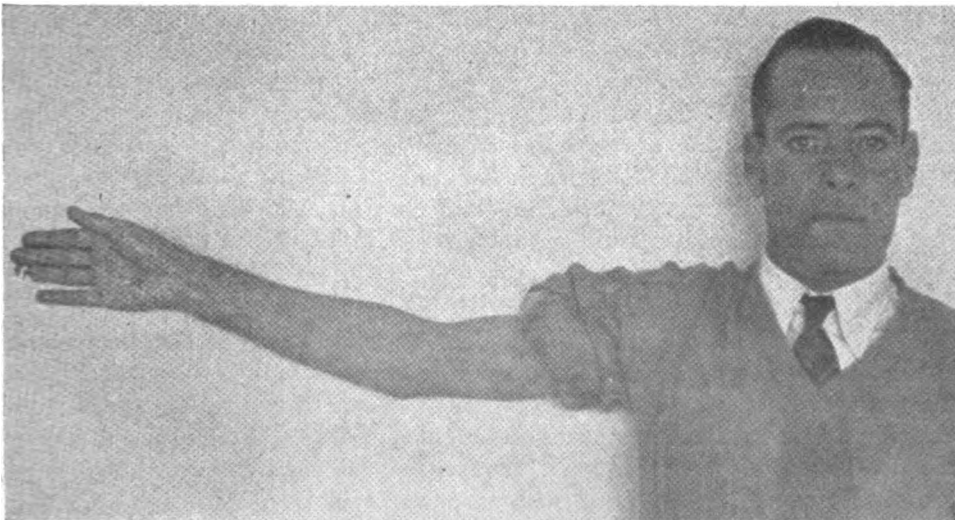


FIG. 7. SAME CASE AS FIGS. 1, 2 AND 6 NINETY DAYS AFTER OPERATION



# A FURTHER OUTBREAK OF FOOD POISONING DUE TO *CL. WELCHII*

BY

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AN outbreak of food-poisoning due to *Cl. welchii* which occurred at Fenham Barracks in the latter part of July, 1953, has already been reported (this Journal (1954), 100, p. 296). The outbreak occurred while one of the two units stationed at the barracks was at camp, so that only one cookhouse was then in use. The present paper summarizes the investigation of a second outbreak of food-poisoning due to *Cl. welchii* which originated in the other cookhouse.

It has recently been stressed that "the relatively mild and short course of this illness and the fact that it is caused by an anaerobe which will escape detection in the usual tests for intestinal pathogens probably explain why this type of food-poisoning has attracted little attention before." (Beck *et al.*, 1954.) It is considered that the present account bears out this contention.

## THE OUTBREAK

Two men reported sick with mild diarrhœa on 14th September, 1953. As there had recently been *Cl. welchii* food-poisoning in the barracks, the remainder of the men in the unit at risk were instructed to report if they had had the slightest diarrhœa following lunch of the previous day. Twenty-five men out of 300 who had dined at the dining-hall in question admitted having had mild colic and diarrhœa on the 14th, including the two who had considered it "worth reporting sick." None of these had vomited and none complained of fever or headache. The onset of symptoms varied in individual cases from six to twelve hours after the suspected meal. All of the affected men were quite fit on the following day and all had remained at duty without requiring treatment. They had all lunched on the previous day at the unit dining-hall, where they had eaten cold boiled mutton. The meat had been boiled for about two hours on the day prior to its consumption and had then been allowed to cool slowly. The next day it was sliced in the cookhouse and served with hot gravy.

## BACTERIOLOGY

Inspection of the cooks and foodhandlers on the morning of 14th September revealed no frank source of likely infection, except the finding of one cook who had gingivitis and a carious tooth. Culture of a swab from his tooth revealed no recognized pathogens and the swab of his gums grew ". . . only several micrococci, a diphtheroid and monilia." He was referred for treatment, but he was not considered a likely source of the food-poisoning.

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The swill bins from the cookhouse involved were emptied and some of the meat served the previous day was recovered. Samples of this meat and of all the available cooked food in the cookhouse were submitted for bacteriological examination.

Fæces from 6 of the affected men were sent for culture within the three days following the outbreak. Heat-resistant *Cl. welchii* was cultured from 5 of the 6 specimens submitted from these patients; and the organism was also isolated in almost pure culture from the mutton which had been salvaged from the swill bins. All other samples of cooked food (freshly-cooked meat, potatoes, custard) yielded no recognized pathogens on culture. No organisms of *Salmonella* or *Shigella* groups were isolated from any of the specimens submitted.

The strains of *Cl. welchii* isolated from these stools and the meat were forwarded to Dr. Betty C. Hobbs, of the Central Food Hygiene Laboratory, London, for serological typing. It was reported that all of the strains produced smooth  $\alpha$ -hæmolytic colonies of Dr. Hobbs' provisional serological type 6.

Eleven days after the outbreak, 12 specimens of fæces were submitted for bacteriological investigation from 12 of the remaining 19 affected men who had not yet been investigated. Heat-resistant *Cl. welchii* was isolated from 6 of these and no other pathogens were found.

The mutton was supplied from a Central Supply Depot within the barracks.

TABLE I.—INVESTIGATION OF THE OUTBREAK

Days after infection	Specimen	Source	Report on culture
1 1	Cooked mutton Meat, potatoes, custard	Swill Cookhouse	Heat-resistant <i>Cl. welchii</i> No pathogens isolated
2 3 4 12	Fæces Fæces Fæces Fæces	Patients 1 and 2 Patients 3 and 4 Patients 5 and 6 Patients 7 to 18	Heat-resistant <i>Cl. welchii</i> from one Heat-resistant <i>Cl. welchii</i> from both Heat-resistant <i>Cl. welchii</i> from both Heat-resistant <i>Cl. welchii</i> from six

TABLE II.—INVESTIGATION OF THE FOODHANDLERS

Days after risk of infection	Days after discovery	Number of specimens (fæces)	Number positive for heat-resistant <i>Cl. welchii</i>	Provisional serological type
24	—	21	5 (A B C D E)	Not done
31	7	5 (A B C D E)	2 (A B)	6
37	13	3 (A B E)	All negative	—
47	23	3 (A B E)	2 (A E)	A=6; E not 6
53	29	1 (E)	1 (E)	Not 1-10
58	34	2 (A E)	1 (A)	Not 6
73	49	1 (A)	1 (A)	Not 1-10
129	105	1 (A)	Negative	—
134	110	1 (E)	1 (E)	Not done
135	111	1 (A)	1 (A)	6
138	114	1 (A)	Negative	—

Random samples of meat and scrim-cloth from the Central Supply Depot and of cooked meat from the cookhouse yielded no pathogens on culture. On the twenty-third day after the outbreak, samples of faeces were obtained from the cookhouse personnel, from the unit butchers and ration truck personnel and from the butchers and foodhandlers employed at the Central Supply Depot—21 men in all, of whom 19 dined at the dining-hall involved. Five of the 21 stools submitted yielded heat-resistant *Cl. welchii* on culture, and of these 5 men, all of whom ate the suspected mutton, 2 persisted to excrete the organism intermittently for at least four months following their discovery (Table II). No organisms of Salmonella or Shigella groups were at any time isolated from these foodhandlers. The carriers were temporarily excluded from food-handling until considered clear.

The strain of *Cl. welchii* isolated from one of the two persistent carriers was consistently not of the provisional serological types 1 to 10. The other persistent carrier, a unit butcher, was found on three separate occasions to be excreting *Cl. welchii* belonging to the provisional serological type 6. It is of interest that, on two other occasions during follow-up, culture of this man's stool also yielded a strain of *Cl. welchii* which did not fall into any of Dr. Hobbs' types 1 to 10, but which was otherwise typical of the food-poisoning strains.

#### DISCUSSION

The simultaneous recovery of serologically identical heat-resistant *Cl. welchii* from the faeces initially submitted and from the suspected mutton justifies the assumption that the contaminated mutton was responsible for the symptoms among the affected men. The bacteriological findings are tabulated in Table I. These results are consistent with the findings in the previous outbreak and with the findings of other authors (Hobbs *et al.*, 1953; Beck *et al.*, 1954). Although no evidence of primary infection of the meat delivered to the Central Supply Depot was obtained, this does not exclude the possibility that *Cl. welchii* was introduced into the barracks in this way. It seems more likely, however, that the source of the present outbreak was the unit butcher who was found to be a persistent carrier of a strain of *Cl. welchii* serologically identical with that isolated from the cases. The patients were not further followed up as it seemed more important, in this second outbreak, to devote the available time to the investigation of the carrier-state in the foodhandlers involved.

It was anticipated that the initial carrier state among the foodhandlers would be high, as all but 2 of these 21 men had dined at the dining-hall involved and it has been shown that as many as 90 per cent. of the persons at risk may become transient carriers of the organism (Hobbs *et al.*, 1953). On the twenty-fourth day after the risk of infection, 5 of the 19 foodhandlers at risk were shown to be excreting heat-resistant *Cl. welchii* and, although it was not possible to follow up these carriers adequately, it is thought that the results indicate the necessity of obtaining at least three consecutively negative stools at weekly intervals before considering a case may be clear. There are not sufficient data to make a more definite conclusion in this respect, but it is evident that, in the present

investigation, several cases have been prematurely considered clear. Although known carriers were excluded from foodhandling, it is highly probable that, as 16 foodhandlers were not further investigated following only one negative stool in each case, several carriers may well have been missed.

Hobbs *et al.* (1953) considered that the prevention of outbreaks of this type of food-poisoning should depend rather on good hygiene and upon the modification of cooking procedures whereby sporulation and multiplication of *Cl. welchii* are not favoured rather than upon the uncertain measure of excluding possible carriers from the kitchen. In the present series, the cooks were instructed to modify their routine as far as was possible to avoid pre-cooking of meat dishes and, where this was unavoidable, to ensure rapid cooling. It seemed unjustifiable to allow known carriers to return to foodhandling in the cookhouse and Central Supply Depot until they were considered clear, as it was not difficult to take this precaution under Service conditions. However, as it seems likely that carriers may have been missed, the fact that no further outbreak occurred appears to support the view that the avoidance of conditions favourable for clostridial sporulation in the kitchen is adequate prophylaxis against further trouble. (The present series does not investigate the possibility that some mild degree of transient immunity may be conferred during initial infection which may tend to mask any symptoms of a subsequent re-infection.)

#### SUMMARY

An outbreak of food-poisoning due to heat-resistant *Cl. welchii* is described.

Twenty-five men out of 300 at risk were affected, and the strains of organism isolated from boiled mutton eaten on the day prior to the outbreak were serologically identical with those isolated from the initial cases investigated.

The personnel involved in foodhandling were investigated and two persistent carriers of a heat-resistant form of *Cl. welchii* were discovered. These men continued to excrete the organism intermittently for at least four months following their discovery.

#### ACKNOWLEDGMENTS

I am again greatly indebted to Dr. C. R. Peck, of the Public Health Laboratory, Newcastle General Hospital, who did the bacteriological work involved in this investigation, and to Dr. Betty Hobbs for her advice regarding the typing of the strains. My thanks are also due to Colonel J. E. C. Robinson, Major D. W. Davies, R.A.M.C., and Major J. Davidson, R.A.M.C. (T.A.), for their kind help and encouragement. For permission to publish this paper I am grateful to the Director-General, Army Medical Services.

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# DEHYDRATION IN INFANTS AND YOUNG CHILDREN

BY

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THE dehydrated child is a worrying and constantly recurring problem both in civil and military hospitals. This is naturally especially so in hot climates where the incidence of infection (particularly bowel infection) is greater. The treatment of the condition is often unsatisfactory and this resulted in the publishing in recent times of an excellent memorandum by the Medical Research Council (The Treatment of Acute Dehydration in Infants, Medical Research Council Memorandum No. 26).

Those who study this memorandum, however, will find that in many of its details it is not applicable in military hospitals and smaller medical units. The reasons for this are :

- (i) Many of the electrolyte solutions recommended (Butler's, Darrow's, sodium-chloride-lactate) are not on the list authorized by War Office for routine production by Command laboratories.
- (ii) Such high potassium-containing solutions are dangerous unless there is rapid and accurate laboratory control by a flame photometer. This is not generally available in military hospitals.
- (iii) These solutions are troublesome to make and the writer is of the opinion that we are not justified in asking the pathological services to make them. It would merely mean that other essential laboratory work would not be done.

It was therefore thought worth while to produce a simplified scheme suitable for the smaller military hospital with limited laboratory facilities, and for medical reception stations often many hours' journey from a hospital. This scheme employs only those electrolyte solutions authorized by War Office and can be controlled adequately by the simpler laboratory tests which can be carried out in the clinical side room. It was originally issued as a poster (21 in.  $\times$  24 in.) suitable for hanging in the duty rooms of medical reception stations and children's and isolation wards in hospitals. For ease of description it has been divided into five sections, and these are reproduced at the end of this article. Sections A and B occupied the left half of the poster and Sections C, D and E the right half.

Section A. Signs of dehydration.

Section B. Tests.

Section C. Treatment.

Section D. Graph of normal maintenance requirements.

Section E. Solutions available and their calorie value.

*Section A : Signs of Dehydration.*

This is a transcript from M.R.C. Memorandum No. 26. It is particularly valuable in that it emphasizes the *early* signs of dehydration when the condition is still comparatively easy to reverse. Probably the commonest cause of dehydration (especially abroad) is diarrhoea and vomiting. On the whole this tends to produce an acidotic condition due to loss of sodium, and shows itself by deep and sighing respiration.

*Section B : Tests.*

This is also a transcript from the above-quoted memorandum, but only those tests which can be carried out in a clinical side room are used.

*Urinary Chlorides.*—The Fantus test is simple and sufficiently accurate. The details are described in Memoranda on Medical Diseases in Tropical and Sub-Tropical Areas (1946), p. 129. Any accessible books of reference have failed to give the normal levels in the early months and years. However, a small series of random samples tested at the British Military Hospital, Singapore, from healthy well-hydrated infants gave the following results :

(a) Neonatal	Urinary chlorides averaged	2.6	Grams/litre (range 2-3)
(b) 2-6 months	„ „ „	2.25	„ „ (range 2-3)
(c) 6-12 months	„ „ „	5	„ „ (range 2-7)
(d) 12-24 months	„ „ „	8	„ „ (range 3-12)
(e) 24-36 months	„ „ „	8	„ „ (range 5-10)

These figures suggest that the power of the infant kidney to concentrate chloride to approximately adult level starts to develop during the second year of life.

*Section C : Treatment.*

This requires little elaboration. In practice sodium chloride counteracts the vast majority of both acidotic and alkalotic states. It is useful to remember that half-strength isotonic glucose-saline solution has a chloride value slightly less than human milk, the natural food. Therefore its use over a prolonged period is unlikely to result in "pickling."

Severe cases may well benefit from an initial transfusion of plasma, and provided the pathologist is satisfied that the risk of serum jaundice is minimal it should be kept in mind.

*Section D : Normal Maintenance Fluid Requirements.*

This is a ready-reckoner graph and with the legend is self-explanatory. It should be noted that it is the maintenance requirements which are graphed. The legend allows for calculation of the initial resuscitation and the daily addition for continuing excessive loss.

*Section E : Solutions Available.*

These are the solutions authorized by War Office for routine manufacture and issue by Command laboratories. Their calorie value is shown for easy

reference. It will be observed that under Section C.8 the phrase used is to "aim." Adequate calorie intake is important but may be very difficult to accomplish. However, it can be increased by perhaps alternating the fluids (e.g., 5 per cent. glucose solution with isotonic glucose-saline) and by the use of hydrolysates. ("Casydrol" is quoted.)

### SECTION A : SIGNS

Signs of dehydration should be looked for in the following circumstances :

- (a) Gastro-enteritis or any alimentary disorder or acute abdominal condition causing vomiting or diarrhœa.
- (b) Fever.
- (c) Lack of appetite.
- (d) Cerebral conditions that produce lethargy or poor sucking reflexes.
- (e) Burns and scalds.
- (f) Hæmorrhage.

The signs are :

	FIRST DEGREE (Mild)	SECOND DEGREE	THIRD DEGREE (Severe)
General appearance and behaviour	Cross, fretful, sleeps fitfully.	More restless and rarely sleeps. May be quiet, may be crying in high-pitched, wailing fashion. Pale anxious face.	Limp, quiet, apparently unconscious, unable to cry.
Thirst ... ..	Thirsty.	Thirst often extreme, but baby vomits. May refuse feeds.	Not apparent, owing to general condition.
Mouth ... ..	Mouth dry; lips bright red; tongue progressively drier, more furred.	Mouth very dry; lips pale, often cyanosed.	Lips cyanosed.
Skin ... ..	Warm, dry; may be red. Elasticity not noticeably impaired, except in a very thin child.	Extremities cool though body may be hot; elasticity markedly diminished.	Skin cold, ashen pallor, cyanosis of extremities.
Eyes ... ..	Bright; may or may not be slightly sunken.	Sunken.	Deeply sunken, rolled up or staring; conjunctival vessels injected; corneæ glazed, mucus dried on them, possibly abraded.
Fontanelle ...	Normal or slightly sunken. In all three stages fontanelle may not be sunken : (a) If increased intracranial pressure (meningitis). (b) If fontanelle is small.	Sunken.	Sunken.

	FIRST DEGREE (Mild)	SECOND DEGREE	THIRD DEGREE (Severe)
Muscle tone ...		Often increased, particularly in acidosis; neck stiffness, twitching, convulsions may occur.	Complete flaccidity.
Body temperature	Assess in conjunction with heart rate		
	Normal or raised.	Usually raised per rectum. Extremities cold.	Usually raised; falling with impending collapse.
Heart rate ...	May be 130-140 per minute.	Rapid (160-180), but rhythm regular, sounds audible over precordium.	Very rapid (often 180+). Sounds difficult to hear. In worst cases slow and irregular.
Respirations : (a) Acidosis ... (b) Alkalosis		May be rather deep and sighing, rate increased. Slow and shallow.	May be deep, sighing. Very slow and shallow.
Urine output ...	Low.	Greatly reduced.	Greatly reduced.
Weight ...	Fall of 2½ to 5 per cent. body weight.	Fall of 5 to 10 per cent. body weight.	Fall of 10+ per cent. body weight.

## SECTION B : TESTS

The following tests may be used to confirm and amplify the diagnosis, or to guide the course of treatment :

Nature of Test	Relative Importance	Frequency	Result	Interpretation
Weighing ...	Essential. May provide earliest evidence of dehydration.	Daily.	Fall of 2½-5 per cent. body weight. Fall of 5-15 per cent. body weight.	Mild dehydration.  Moderate to severe dehydration. Clinical state worse if loss has been rapid.
Urine volume	Essential to attempt an assessment.	As voided.	Fall in output.	Fluid intake low or extrarenal losses high.
*Silver nitrate test for chlorides	Useful for distinguishing between water and salt depletion.	At first examined as voided. Later, once daily throughout dehydration phase.	Present.  Absent or low.	Water depletion with little or no salt depletion.  Salt depletion.
Albuminuria and microscopic examination of deposit	To exclude urinary infection and renal disease.	As above.	Present with oliguria. Present later.	Dehydration.  Renal disease.
Acetone and ketone bodies	To exclude ketosis.		Present.	Ketosis contributing to acidosis.

\* See *Memoranda on Medical Diseases in Tropical and Sub-tropical Areas* (1946), p. 129.



## SECTION C : TREATMENT

Diagnose the cause.

Assess degree of dehydration.

Plan treatment for next 24 hours, calculating

- (a) fluid and electrolyte requirements,
- (b) calorie and protein requirements,
- (c) vitamin requirements.

Treat the causal infection.

1. The results of inefficient treatment in the first 48 hours may be very difficult to overcome.

2. A plan of fluid, electrolyte and calorie administration must be made for each 24-hour period.

3. **INTAKE AND OUTPUT CHART.**—This should be completed each morning for the previous 24 hours under the headings fluids, electrolytes, proteins, total calories and vitamins. **IT IS ESSENTIAL TO TRY TO ESTIMATE THE LOSS BY URINE, VOMIT AND FÆCES.**

#### 4. METHOD OF ADMINISTRATION :

- (a) **First Degree** (often missed). Usually orally, but if vomiting may need to give subcutaneously with hyaluronidase, or rectally.
- (b) **Second Degree.** Must have fluids parenterally; sometimes subcutaneously with hyaluronidase: often intravenously will be required. Gradual substitution with oral fluids after 24 hours.
- (c) **Third Degree.** Intravenously always required. It may be possible to start oral fluids after 24 to 36 hours.
- (d) Subcutaneous administration should not be continued for more than 24 hours. Glucose solutions should never be given subcutaneously for fear of abscess formation.
- (e) Oral feeding should be introduced gradually over about 3 days, substituting one-third orally the first day and two-thirds orally the second day.

5. **AMOUNTS OF FLUIDS.**—See graph. In infants aim to give 100 to 120 c.c. per lb. in the first 24 hours. Thereafter this can be dropped to about 80 c.c. per lb. per day.

6. **RATE OF ADMINISTRATION.**—At first (2-4 hours) 5-10 c.c. per lb. per hour: thereafter 3-4 c.c. per lb. per hour. In bigger children the rate will be somewhat less.

7. **TYPE OF FLUIDS.**—The urinary chlorides are used as a guide. Initially (2-4 hours) probably normal saline or isotonic glucose-saline. Thereafter half-strength glucose-saline, or glucose-saline alternating with 5 per cent. glucose,

*i.e.*, once stage of maintenance is reached give approximately the equivalent of N/4 to N/6 saline.

After 48 hours protein must be given (aim at 1 gramme per lb. per day) to prevent anæmia. If anæmia develops after about 5 days a small transfusion of blood is useful (10-20 c.c. per lb. according to severity).

Potassium. It is safer not to give this for several days. It may then be administered as Hartmann's solution by mouth.

*Note.*—(i) The importance of testing the urine daily for chlorides.

(ii) There is a danger of "pickling" the baby by the over-administration of sodium chloride. However, this danger is considerably less when the dehydration is due to diarrhœa or vomiting.

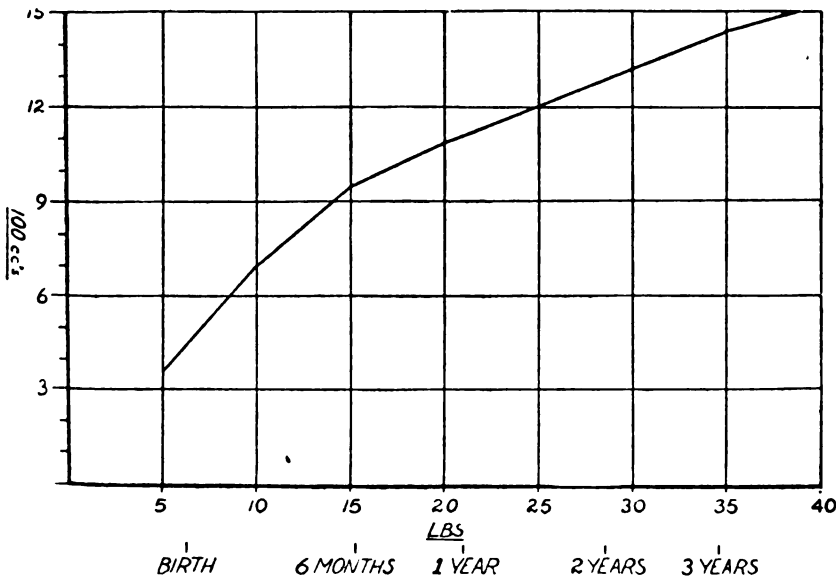
8. CALORIE REQUIREMENTS.—At first (*i.e.*, resuscitation stage of up to 4 hours) the overriding consideration is fluid and electrolyte replacement. Thereafter aim, in infants, to give 20-30 calories per lb. per day, rising gradually over 3 to 4 days to 50 calories per lb. per day.

9. RESUMPTION OF MILK FEEDING.—This should be introduced gradually, starting with 10 calories per lb. per day in the form of milk, possibly pausing at 30 calories per lb. per day until the stools return to normal, and then gradually raising to the normal maintenance of 50 calories per lb. per day.

#### SECTION D :

##### NORMAL MAINTENANCE FLUIDS REQUIREMENTS IN TEMPERATE CLIMATES

Probably comparatively little adjustment is needed in the warm, moist climate of Malaya. Adjustment will, of course, be required in hotter, drier climates.



1. In mild to severe dehydration  $2\frac{1}{2}$  per cent. to 15 per cent. of body weight will have been lost in body fluids. This will need to be added the first day.
2. In addition, the continuing loss by vomit, stools, urine and excessive perspiration must be added. This may mean up to 33 per cent. above daily maintenance.
3. During the first week of life the daily maintenance requirements should be  $1/7$  increasing to  $7/7$  of that for older children.
4. Big babies require relatively less fluid per lb. daily for maintenance.

## SECTION E : SOLUTIONS AVAILABLE

Normal saline (0.85 per cent. NaCl) ...	Isotonic			
Glucose-saline (Glucose, 3.3 per cent., NaCl 0.3 per cent.) ... ..	Isotonic	Calories per 100 c.c. =	14	
Half-strength Glucose-saline ... ..	Hypotonic	" "	"	7
5 per cent. Glucose in water ... ..	Isotonic	" "	"	20
10 per cent. Glucose in water ... ..	Hypertonic	" "	"	40
Blood ... ..				
Plasma ... ..				
*"Casydrol" (Benger's) (Aminoacids, 5 per cent. ; Dextrose, 5 per cent. ; NaCl, 0.3 per cent.) ... ..	Hypertonic	" "	"	40
National Dried Milk (approx. Protein, 3.3 per cent. and N/4 NaCl) ... ..		" "	"	60

## SUMMARY

1. A simplified scheme for the diagnosis and treatment of dehydration in infants and young children is submitted.
2. Only those electrolyte solutions authorized by War Office are used and use can be adequately controlled by simple clinical side room tests.
3. The following points are emphasized :
  - (a) The importance of early recognition.
  - (b) The importance of really adequate treatment initially.
  - (c) The danger of giving potassium intravenously without proper control.
  - (d) The importance of giving protein after 48 hours.
  - (e) The importance of an adequate calorie intake.
4. A poster embodying the scheme is described, suitable for hanging in appropriate duty rooms.

## ACKNOWLEDGMENT

I wish to thank Brigadier D. Bluett, O.B.E., M.A., M.B., Director of Medical Services, Far East Land Forces, for permission to submit this article for publication.

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\* For children, dilute 1 : 1 with half-strength glucose-saline.

## “ . . . THIS STRANGE EVENTFUL HISTORY ”

BY

Colonel D. P. HOLMES, T.D., M.D.

THE history of an unusual case is considered worthy of record as it illustrates many features of interesting pathology. The events take place over a number of years, from the original occurrence of a gunshot wound in 1917, age 21, to the patient's decease in 1953, age 57, and are set out in sequence with the avoidance of unnecessary detail. Short discussions are interposed where most relevant, to avoid a more lengthy discourse at the end of the article.

The condition starts with a gunshot wound of the left hip in 1917 which resulted in disorganization of the hip with shortening of the leg. The pelvis in the region of the left hip joint showed sequestra and retained foreign bodies radiologically, and clinically several discharging sinuses were evident. The discharge persisted, varying in character from muco-purulent to frank pus and varied in amount. At no time did it cease altogether. In addition, there were acute “flares” occurring with some regularity at approximately six-monthly intervals and requiring admission to hospital. These incidents subsided satisfactorily with conservative treatment and no further surgery was thought advisable. Amputation would have had to be at the hip joint and would not have cured the condition nor permitted a satisfactory prosthesis. As described, this is a typical case of old bony injury with chronic osteo-myelitis, and a large number of such were seen between the two wars. The story told is a typical one of persistent discharge and recurrence of acute attacks of swelling and inflammation. These acute phases are interesting because in one's own experience they do not seem to have any causative factor. Unnoticed trauma may occur at any time, but over a large number of cases seen, no such incident has ever been noted and one would expect that there would be some association in at least some of them. Moreover, unlike this particular case, the majority do not have any regularity in the cycle of their attacks. One has seen a recurrence within a matter of weeks followed by fifteen years' remission. One has also seen an acute exacerbation occurring for the first time more than thirty years after the original wound. They are cases in the treatment of which masterly inactivity is the undoubted line to be pursued and attempts at radical drainage do no good and may even cause harm. Cases have been seen where an enthusiastic surgeon has attempted to lay open the seat of mischief, and although his extensive incisions were worthy of better reward, the abscess has pointed just alongside one of them ! The explanation of this is considered to be that the disorganized tissues permit drainage to occur through a track of least resistance and that, such having been formed, it is quite effectively walled off. A further incision would only lead to further scar tissue formation, and the greatest efficiency is obtained by easing of pain until the place of pointing can be clearly seen beneath the skin, when it can be assisted in its final exit. Treatment by chemotherapy or any agent introduced via the blood-stream is disappointing, and the explanation of this is somewhat similar to that of the

tracking of the pus. The bone can be seen radiologically to be thickened and dense and can have but little blood supply. Any substances administered parenterally, therefore, simply do not reach the site. The factor causing the flare is totally indefinite. It has been described as a breaking down of the balance between resistance and infection, and while this is so, the reason for such is still not ascertained. Sound advice to give to the patient is not to worry about a recurrence which may never take place, but to have treatment for it at the first sign of acute mischief. Cases have been noted where well-intentioned instruction has been given to avoid any possible trauma and men have made their lives very restricted and very unhappy, only to see a flare occur in spite of all their precautions, and such is only adding further limitation of life to one already afflicted. Chronic bone sepsis is not seen so frequently in World War II cases as in World War I. There are several factors that may account for this, but in general the explanation is considered to be that World War I was largely fought in trenches with constant shelling and wounding by fragments. Everything was, therefore, favourable to infection, by no means least being the clothing taken into the wound, and there were, of course, no antibiotics available at that time. While clothing would invariably be grossly contaminated, it is an interesting contra-reflection that one has personally removed a sizeable piece of the tongue of an Army boot from the dorsum of a foot, twenty years after wounding, and at no time had sepsis been present !

Reverting from general discussion of such cases to the individual case in question, the cycle of acute phase and remission went on until June, 1945, when a new factor was described, that being severe clinical anæmia. This was confirmed by blood count and it was noted that all constituents of the blood were reduced, with red cell count of approximately 2,000,000, white cells 5,000 and colour index unity. Following transfusion with concentrated red cells, considerable improvement resulted and the count was raised to 3,500,000 red cells, 11,000 white cells, colour index unity. The first transfusion was given in July, 1945, and thereafter the cycle has added to it one of progressive anæmia. This was not related to the acute exacerbations of the hip condition and seemed to be a progressive state. Frequent admissions to hospital at approximately six-monthly intervals now became necessary in order that the blood picture could be brought up to a reasonable state and two counts are quoted as being illustrative. In May, 1948, red cells were 1,500,000, white cells 6,000, colour index slightly over unity. After repeated transfusion, six months later (December, 1948) the count was red cells 3,250,000, white cells 11,000, colour index unity. In no count was there any evidence of grave disturbance of the proportions of white cells. From the diagnosis of anæmia in 1945 until 1953, the treatment became almost routine. The hip condition was now much more stable as a simple chronic osteo-myelitis with constant discharge but without flares, and the symptoms were those of progressive anæmia. It was clear that the man was literally living on "borrowed blood" and that his own bone marrow was incapable of production to a degree adequate for his needs. He was considered to be a case of secondary aplastic anæmia. As one would expect, no improve-

ment followed liver therapy tried in many forms. In October, 1953, transfusion was followed by a reaction of headache, pyrexia and rigors. This was the first time such had occurred, although no fewer than forty-three pints of blood had been given. In 1953, during in-patient treatment lasting five months, seven pints of concentrated red cells had been administered. The blood count in the middle of November was : red cells 1,600,000, white cells 1,000, hæmoglobin 39 per cent., colour index 1.15, and it was obvious that the general condition was deteriorating. On 28th November, œdema in the left leg was noticed and the occurrence of this coincided with a diminution in the amount of urine passed. Within three days both lower limbs had become severely œdematous and there was abdominal distension. The veins over the chest wall were noticed to be prominent and pigmentation of the skin was evident. This was of dark brown colour and strongly resembled sunburn. There was marked ascites and the spleen was readily palpable as being grossly enlarged. The urinary output was low and urine contained a considerable quantity of albumin. It was clear that the end was approaching and further transfusions were not undertaken, nor was any detailed investigation likely to reveal anything which would enable any therapeutic measures to be instituted. The condition now resembled amyloid disease except for the pigmentation, and caused considerable discussion which raised a further point of interest. No member of the hospital staff could recall a case of chronic bone sepsis producing amyloid disease, although one would expect such to be a textbook cause, and it was ascertained that in a period of thirty-two years no such complication had arisen. The reason one would suggest for this is that the bone sepsis is so shut off from the circulation as not to cause lardaceous change. This may well be so, but in this case there is no doubt that the absorption was sufficient to produce failure of bone marrow and blood formation. Apart from the emphasis on the absence of amyloid complications in other cases, one must leave the matter open.

The patient died on 28th December, becoming progressively weaker. Autopsy showed all the diagnoses to be correct save the last. The condition was one of aplastic anæmia attributed to chronic bone sepsis and the final developments were due to hæmosiderosis. This in turn was attributed to the repeated transfusions which had been necessary. One can, therefore, conclude by saying, although this was a case of the utmost interest, he did *not* form the first case of amyloid disease seen in bone sepsis and such has yet to be encountered.

The condition of "transfusion hæmosiderosis" has been described in several cases in recent medical literature. The post-mortem appearances resemble those of hæmochromatosis and clinical diabetes has occurred from involvement of the pancreas. The reason for the deposit of hæmosiderin is not understood except in the somewhat vague explanation that under certain circumstances the body seems to retain all the iron it can.

It is desired to acknowledge the assistance of the Department of Pathology of the Cardiff Royal Infirmary in the demonstration of the post-mortem findings, and of the Chief Medical Officer of the Ministry of Health for permission to publish the article.

# ANKLE FUSION AFTER COMPLETE TALECTOMY IN FRACTURE DISLOCATION OF THE TALUS

BY

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*Consulting Orthopædic Surgeon*

THE purpose of this paper is to describe a method of tibio-calcaneal fusion following talectomy for fracture-dislocations of the talus and to point out that a comely ankle results if the lower end of the fibula is also removed.

Opportunity is also taken to state that this service injury is not confined to R.A.F. feet (Osmonde Clarke, 1953; Watson Jones, 1943), as during the past three years six such injuries were admitted to the Orthopædic Centre, Cambridge Military Hospital. All were soldiers and in each the trauma was caused by the same mechanism: after jumping an obstacle, such as a ditch, a vaulting-horse in the gymnasium or an obstacle during battle training, they landed heavily on the affected foot with sudden forced dorsiflexion at the ankle joint. At the same instant the forward and downward momentum of the body-weight thrust the anterior surface of the lower end of the tibia into the neck of the talus to fracture it. This momentum, pivoted on the ankle joint mortice, continues and the body of the talus is violently squeezed out of the mortice like a pea out of a pod. This displacement is medially and backwards, with rupture of all the ligaments attached to the talus, and may be associated with comminution of the medial malleolus.

## CASE REPORT

Fig. 1 shows such an injury which occurred in Malaya in March, 1952. Open reduction was performed, but infection supervened and in April the talus was removed after resecting the lower end of the fibula. In May he was transferred by air to the Orthopædic Centre, Cambridge Military Hospital, where it was evident that, although a sinus was present, infection was subsiding. After rest in an above-knee plaster complete resolution had occurred (Fig. 2), but after five months' plaster fixation the small joints of the foot were stiff. He was allowed to walk in double below-knee irons and an intense drive at rehabilitation of the foot was made prior to ankle fusion.

In February, 1953, the fore foot was mobile and painless, but there was crippling pain on walking even one step at the fibrous ankylosis between the tibia and the calcaneus. Therefore fusion via a lateral incision was performed by resecting the fibrous tissue and exposing cancellous bone between the lower end of the tibia, the upper surface of the calcaneus, and the lower anterior surface of the tibia and the neck of the talus, and into the resultant gap cancellous chips were packed. The foot was positioned at right-angles to the tibia so that the neck of the talus was in apposition to the lower anterior surface of the tibia.



FIG. 1



FIG. 2

*Facing page 60*



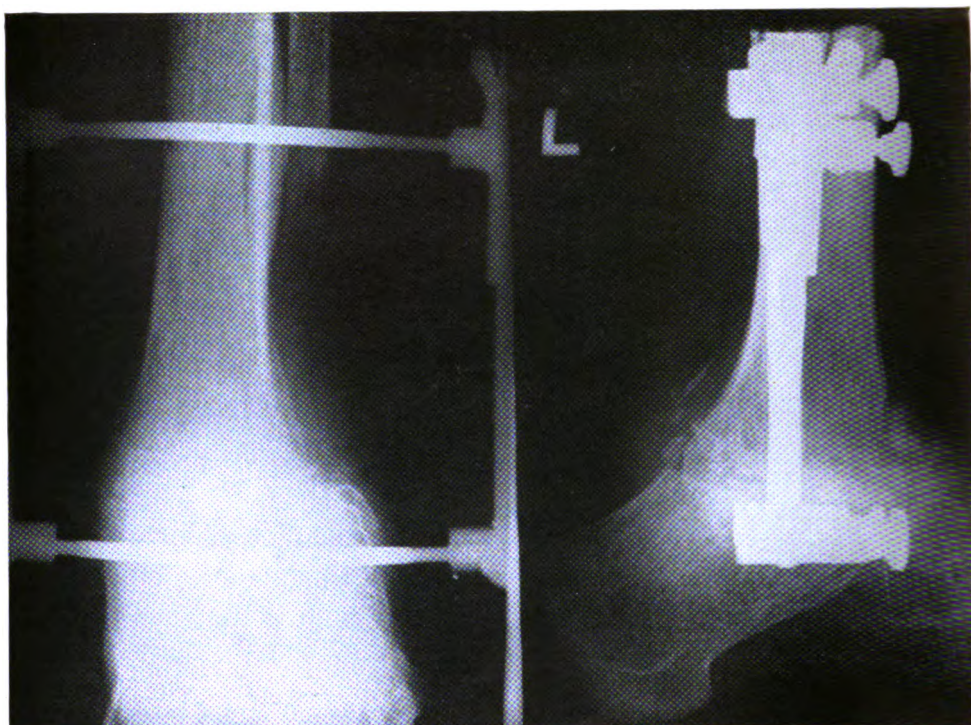
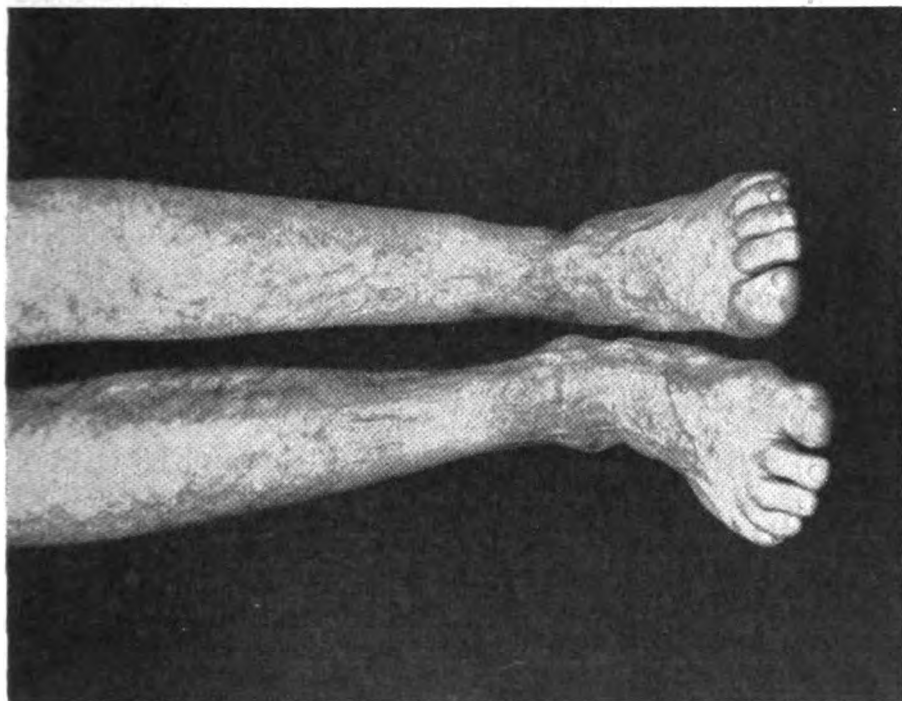


FIG. 3



FIG. 4



**FIG. 5 (b)**



**FIG. 5 (a)**

The compression principle (Charnley clamps for knee fusion) was used (Fig. 3) and the leg enclosed in an above-knee plaster. Six weeks later the pins and the plaster were removed and bony union was found to be firm. A below-knee walking plaster was applied for a further six weeks and, when removed, union was radiologically and clinically consolidated. He was allowed to walk at once, and the dramatic change from the crippling pain of the talectomy to the painless walking of ankle fusion can only be appreciated by the patient.

Five months after operation he was reviewed. He had remained pain-free, the fusion was complete and the midtarsal foot range was excellent (Fig. 4). Further follow-up shows that he continues to be pain-free.

*Comment.*—This is one method of fusing this region, which in this one patient rapidly produced a pain-free solid fusion. He had to wear a surgical boot to compensate for the shortening of the limb but not to accommodate the usual ugly bulging ankle region that results from this operation. In fact, if the lower end of the fibula is resected, this area looks pleasantly like an ankle (Fig. 5). A point was made to place this foot at right-angles to the tibia. Previous experience with ankle joint fusions in soldiers has shown that the plantar grade foot gives a better functional result in the heel-to-toe walking in any type of footwear than a foot placed in any degree of equinus. Such fusions can return to and remain at duty. The case described above was invalided from the Army because of the shortening and the need to wear hand-made surgical footwear to compensate for this.

I wish to acknowledge the kind permission of the D.G.A.M.S. to publish this case.

#### REFERENCES

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- WATSON JONES, SIR REGINALD (1943). *Fractures and Joint Injuries*. Edinburgh: E. & S. Livingstone.

## AN INSTRUMENT TRAY FOR USE WITH THE M. & I.E. TRANSPORTABLE ANÆSTHETIC MACHINE

BY

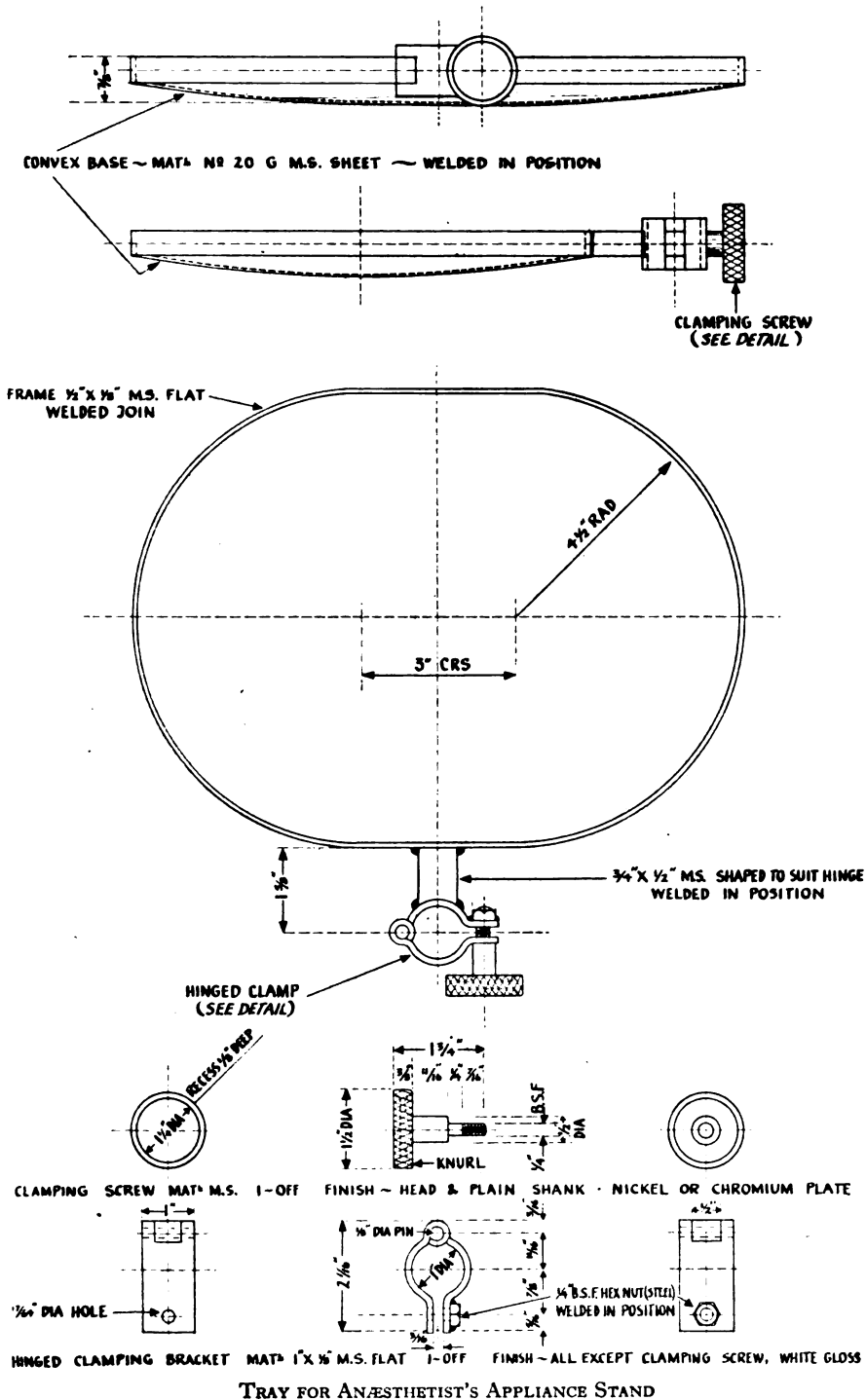
Lieut.-Colonel T. McERVEL, M.B., F.F.A., R.C.S.

*Royal Army Medical Corps*

*Senior Specialist in Anæsthetics, Cambridge Military Hospital, Aldershot*

THE M. & I.E. Transportable Anæsthetic Machine, for all its great scope and mobility, has the disadvantage that there is no safe place on it to put the numerous syringes, etc., which the anæsthetist uses in these days of polytherapy.

A tray has therefore been designed, with the kind assistance of Lieut.-Colonel



J. M. Lyden, *O.B.E.*, *R.E.M.E.*, and manufactured by his technicians, which appears to overcome this defect.

Specifications are shown in Blue Print M.Z. 1069 (see Fig.)

The efficient clamping screw and bracket enable the sturdy tray to be fixed firmly to the column holding the "Head" of the machine and equally easily rotated to any desired position in the column when access to any particular valve, etc., is required. This mechanism can easily be adapted for use with the Marrett machine, which has the same requirements, by fitting a sleeve.

## *Editorial*

### THE CENTENARY OF ARMY PATHOLOGY

A CENTENARY, or indeed any other anniversary, commemorates an accomplishment, and the glory of achievement is apt to outshine the painstaking work which led up to it. So it is with the centenary of pathology in the British Army, which we celebrate this year: we are recalling not inception but recognition, for there is abundant evidence, to seek no further than the Millbank library, that the thoughtful clinician who followed his patient from the ward to the dead-house was as common in the Army as in civilian practice, perhaps commoner, fifty years and more before the day in 1855 when Dr. R. D. Lyons and Dr. William Aitken, pathologists, sailed for the Crimea to investigate the causes of the morbidity and mortality in the Army of the East, which were so disturbing to enlightened opinion at home.

The autopsy reports of the British hospital at Lisbon in 1827; J. F. Smet's *Quarterly Dissection Reports* and his statement that necropsy was performed in every fatal case "except when, from the funeral party being in waiting, or the time taken in dissecting some other body, it was not found practicable"; the Fort Pitt post-mortem reports; John Davy's *Some of the More Important Diseases of the Army with Contributions to Pathology*, published in 1862 but based upon notes of 1,060 fatal cases; letters from hospitals in Brussels, crowded with the wounded from Waterloo—all these clearly indicate that in peace and war it was accepted that the logical sequel to a patient's death was a search for the cause of it. We recall with pride that the first incumbent of the first-established Chair of Pathology in the United Kingdom, John Thomson, had before his appointment to it been Regius Professor of Military Surgery in Edinburgh, and that he had spent six years as a medical officer in the Regular Army. It was Thomson who deplored the scanty contributions, minute in relation to their experience, which British military medical officers had made to the literature of their profession. Such contributions were not encouraged by the conditions of service in his day and no grants were available to aid research. This therefore remained entirely dependent upon a largely fortuitous union between inspiration and opportunity. If St. Thomas the Apostle (who might well be taken as the patron saint of pathologists) wrote a gospel, it has not survived, but the fruit of his work is still in the Church. So in military pathology—and there is no better example than Sir William Aitken, the Father of Army Pathology—teachers have outnumbered writers.

The roots of pathology have been seen in the green fingers of the thoughtful clinician, but the establishment of a Chair of General Pathology in Edinburgh in 1831 was testimony that pathology had been planted as a separate branch of medicine. At the same time, views on medical education, leading to the Medical Act of 1858, were hardening, and the inquiries into military medicine in the

Crimea probably hastened only slightly the inevitable conclusion that the instruction offered to probationers for the Army Medical Department, first at the York Hospital and later at Chatham, was inadequate. Friction and inertia braked the wheels, but when an Army Medical School was opened in Fort Pitt in 1860, and the staff included from the beginning a professor of pathology, Aitken's work in 1855 marked him as the obvious choice for the Chair. From then until death anticipated his retirement by a bare month in 1892, Aitken taught every probationer who entered the service.

From the first, there was a "Microscopical Room" in the Army Medical School, though thirty years later medical graduates were entering the service never having looked down a microscope until they did so under Aitken's eye. The probationers' post-mortem reports clearly show the careful methods which were inculcated, and contemporary evidence leaves no doubt that Aitken was a convincing, perhaps even an inspiring, teacher with a particular ability in demonstrating morbid appearances and correlating them with clinical findings.

The period of Aitken's professorship was one of continuous expansion in pathology. For us in the Royal Army Medical Corps, his sailing for the Crimea is not less a landmark than Virchow's enunciation in 1855 of the memorable *Omnis cellula e cellula* or the publication of Pasteur's first paper in 1857. Opportunity was wide open; profitable lines of research were apparent at every turn; organization there was little, and in the British Army, outside the Army Medical School, none. But there was nothing to prevent the individual from working at the problems which presented themselves in his own time and largely at his own expense. It was thus that Bruce studied bacteriology under Koch in Berlin, and Leishman's taking a microscope to India was regarded as an eccentricity. The causes of disease were beginning to be found.

But as Almroth Wright replaced Aitken at Netley, the day of the individualist was already beginning to pass. Of twenty-five papers reprinted in Wright's *Studies on Immunisation* (1909), fourteen had been written in collaboration. Schools of pathology were by now established everywhere, and the best work was being done in them by pupils and assistants under the guidance of the master. Elsewhere, voluntary association of kindred minds, laboratory workers and clinicians alike, was being found more profitable than single-handed effort. Further, the success which was attending the search for the causes of disease was naturally encouraging experiment towards means of preventing them.

The tenure of the third Professor of Pathology, William Leishman, was to see voluntary association replaced, in its turn, by organized, directed research. The Anti-typhoid Committee directed by the War Office, the Sleeping Sickness and Malta Fever Commissions, organized by the Royal Society for the Colonial Office, were early examples of centrally controlled investigation. Leishman himself was a foundation member of the Medical Research Committee (later the Medical Research Council). After the South African War, the Army Medical Advisory Board was established to make available to the Director-General advice from leaders of the civil medical profession. Its success led to the crystallization of various war-time consultative committees into the Army



Pathology Advisory Committee when the Directorate of Pathology was formed in the War Office in 1919.

It is perhaps in this body that the pattern of Army pathology is most clearly seen. The visitor to one of its meetings will search in vain for the hæmatologist, for the chemical pathologist, even for the morbid anatomist (or "pure" pathologist); it is a committee of bacteriologists, parasitologists, virologists, and immunologists: workers interested in infections with living organisms and their prevention. The work of Wright and Leishman on anti-enteric inoculation, of Semple on rabies, of Bruce and Hughes on undulant fever, set a pattern for Army pathologists to follow, in applying knowledge, skill and resources primarily to the protection of the health of the soldier. In addition, the share which Army pathologists have always taken in the discussions and decisions on the medical aspects of defence problems arising from actual or potential developments of scientific warfare bears witness to their interest in that subject also, an interest which goes back at least to Leishman's day. When specialization was first permitted in the Corps, we had on the one hand specialists in the prevention of disease, on the other specialists in bacteriology. They worked hand in hand, and reading their papers fifty years later frequently leaves one wondering in which subject an author was noted as having specialized. So today: diagnostic pathology may loom largest in teaching programmes and in laboratory bench work, but preventive pathology has the firmest claim to the allegiance of the Army pathologist. The specialist in the prevention of disease was to be renamed the specialist in hygiene before he became the specialist in Army health: within the last year, one of them has described himself in this Journal as a social pathologist.

This centenary year of Army pathology is also the centenary of Sir David Bruce's birth.\* When it was realized that the work of the Army Vaccine Laboratory was no longer fully reflected in its name, it was redesignated the David Bruce Laboratories. Bruce, as assistant professor to Wright, had shared in some of the earliest immunological work carried out in the Army: he had been Commandant of the R.A.M. College, of the Vaccine Department of which the David Bruce Laboratories are the lineal descendant: he had never missed an opportunity of investigating a problem, and his researches, on cholera, on Malta fever, on sleeping sickness, on tetanus, had one end only—a serious endeavour to protect the soldier from preventable disease. The closing of the Army Blood Supply Depot led to the formation of a Transfusion Department at the David Bruce Laboratories—a blending of preventive surgery with preventive medicine. When Army pathology celebrates its bi-centenary, will it have added a department of psychoprophylaxis?

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\* The next (April) issue of the Journal will be a Bruce Centenary Number.



## *Correspondence*

ROYAL COLLEGE OF SURGEONS OF ENGLAND,  
LINCOLN'S INN FIELDS,  
LONDON, W.C.2.

*2nd June, 1954.*

MY DEAR HARRIS,

Thank you very much indeed for sending two cheques for £15 15s. each to cover the cost of two chairs in our new Great Hall. I am most grateful to the officers of the Royal Army Medical Corps for their generosity in making this handsome donation to the College and I can assure you that my Council and I are delighted to know that the Corps is to be commemorated in the College in this way. The gift will be yet another reminder of the happy relationship which has always existed between the Army and this College, and I should be glad if you would convey my deep appreciation to all the officers who have made this presentation possible.

With kind regards,

Yours sincerely,

CECIL WAKELEY,

*President.*

LIEUTENANT-GENERAL SIR FREDERICK HARRIS, *K.B.E., C.B.*,  
*Director-General, Army Medical Services.*

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## *Matters of Interest*

### HYDRAULIC STRETCHER GEAR

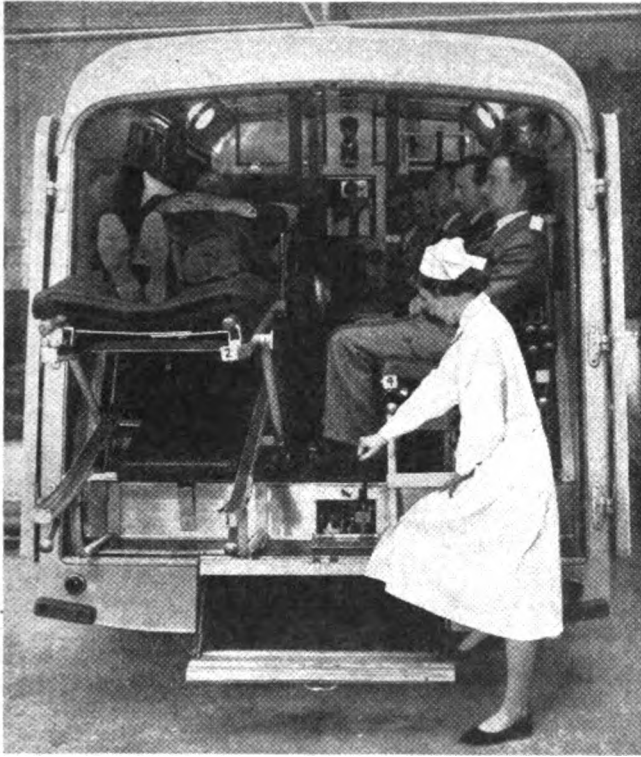
A NEW Hydraulic Stretcher Gear which enables heavy patients to be loaded into the top tiers of a four-berth ambulance was exhibited at the Commercial Motor Show by Appleyard of Leeds Ltd. (Coach Building Division).

The unit is simple in design and foolproof in operation.

The upper tier stretcher gear, supported on four pivoted tubular steel arms, is raised or lowered hydraulically from a lever-actuated pump built into the step-well at the rear of the ambulance. In its lowered position it descends into exactly the same position as the lower tier stretcher gear and accessible controls are at hand to regulate the speed of the operation.

Safety devices are incorporated which automatically lock the tubular arms in a vertical position at maximum height, and it is impossible to close the doors of the ambulance until this lock has been effected. In addition, a restrictor valve in the hydraulic cylinder safeguards against fault in the hydraulic system. In the unlikely event of a leakage, the top tier can only descend very slowly and gently without any danger to the patient.

The lower tier is the standard Morris Commercial low loading pattern which allows patients to be loaded without the attendants entering the ambulance, and without any lifting whatsoever.



THE ILLUSTRATION SHOWS, ON THE NEAR SIDE, A STRETCHER BEARING A PATIENT BEING PUMPED UP INTO POSITION BY THE NURSE. ON THE THE OFF SIDE, THE DOUBLE-TIER STRETCHER GEAR HAS BEEN CONVERTED INTO ITS ALTERNATIVE FORM—A BENCH SEAT WITH BACK-REST—AND IS SHOWN CARRYING FIVE SITTING CASES

An interesting additional feature of the unit is that the top stretcher gear is collapsible, allowing the ambulance to be used for the carriage of up to ten sitting cases when the occasion demands. Either or both of the top deck stretcher carriers can be folded down to form a back rest for patients sitting on upholstered seats which are included in the equipment and stored in the frame-work of the lower gears.

### THE SOLDIERS', SAILORS' AND AIRMEN'S FAMILIES ASSOCIATION (S.S.A.F.A.)

"S.S.A.F.A. CHAMPIONS THE CAUSE OF SERVICE FAMILIES"

ALTHOUGH it was in 1885 that Major (later Colonel Sir James) Gildea first formed what was to become the Soldiers', Sailors' and Airmen's Families Association, it is surprising how few people realize the full scope of this now

very large organization, which has been in continuous existence since that date. Even as far back as the Boer War this Association spent over one million pounds helping Service families. The expenditure in both the First and Second World Wars was many times as large.

Now that we are at peace, however, what can S.S.A.F.A. do to help the family of the serving and ex-Service man? First and foremost, it is a welfare organization designed to look after every aspect of family welfare. S.S.A.F.A. tries, when the Service man is separated from his family, in some measure, to take his place, for all of us know how difficult it is for his wife to deal with the many problems of present-day living without the help of her husband.

The Overseas Service of S.S.A.F.A., which started during the last war, and which has representatives in the main Commands overseas, exists to help in all the many problems that arise through separation.

Throughout the British Isles there are 15,000 voluntary representatives of the Association, who can visit families in their own homes and can give them practical help. This help may take the form of advice or, in necessitous cases, an immediate grant. These representatives also visit and report at the request of Regimental Associations.

The S.S.A.F.A. Clothing Branch can provide bedding, clothes and footwear for families with small incomes, who owing to the high cost of living have little or no margin to meet all their clothing requirements.

When father is away and mother falls ill the problem often arises as to who can look after the children. The answer lies in Springbok House, near Chelmsford, where S.S.A.F.A. takes care of small boys and girls in happy, friendly surroundings.

S.S.A.F.A. runs a Nursing Service, consisting of qualified hospital-trained nurses, who look after the health of the children and mothers in overseas stations. The entire cost of the Nursing Service is now borne by public funds, but it is still administered and controlled by the Association.

When visiting or passing through London there is always a demand for an inexpensive but properly conducted club or hostel where Service or ex-Service families can stay. In Nevern Square, London, the S.S.A.F.A. Married Families Club provides hotel amenities for families, with special facilities for children, and has frequently helped stranded families to find both shelter and advice. The Club operates without profit.

These are some of S.S.A.F.A.'s more obvious activities, but most of the Association's work takes place behind the doors of modest-looking homes where families seek to hide their grief and trouble from the curious gaze of the outside world. And because S.S.A.F.A.'s thousands of voluntary workers have scrupulously respected the myriad confidences they have received, much of the Association's most intimate work remains unknown. For, in fact, S.S.A.F.A. is more than just a large Service Fund. It is a flexible and experienced welfare organization, designed and equipped to help the Service and ex-Service family in all its difficulties, however personal and however varied.

## PAPERS BY R.A.M.C. OFFICERS

- Mackay-Dick, Lieut.-Colonel J., and Rothnie, Captain N. G. : The Management of Serous Primary Pleural Effusion in Young Adults. *Tubercle* (1954), **35**, 182-187.
- Nield, Eric : With Pegasus in India. *Pegasus—The Journal of Airborne Forces* (1954), **9**, 3-6.
- Nield, Major F. G. : The West German Health and Social Services. *Public Health* (1954), **67**, 156-163.
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**Book Reviews**

**PULMONARY TUBERCULOSIS.** By Walter Pagel, M.D., F. A. H. Simmonds, M.A., M.D., D.P.H., and Norman Macdonald, M.B., M.R.C.P., Ed. Oxford University Press. 1953. Pp. xiii+728 (illus.). 84s.

This is the third edition of Kayne, Pagel and O'Shaughnessy's *Pulmonary Tuberculosis* and the second edition undertaken by the present authors. Advances have been such that in the space of five years much of the text has had to be rewritten. The rapid advance of surgery in this field is illustrated by the fact that nothing remains of the 1939 surgical text. It is a book of reference in which all aspects of the subject are dealt with thoroughly. The layout of the book and the development of the subject material are excellent. A full and up-to-date bibliography is found at the end of sections or chapters.

The section on Pathology is authoritative and complete, an admirable feature being the introduction of clear summaries at the end of appropriate sections.

In the clinical section it is emphasized that diagnosis involves a complete understanding of the patient physically and mentally and that management of the patient is important rather than treatment of lesions. Such principles are often forgotten.

The illustrations have been carefully selected and annotated. The reproduction is clear and of high quality.

This book is confidently recommended as a valuable book of reference for all physicians and an invaluable textbook for chest physicians.

J. P. B.

**INFLUENZA.** A Review of Current Research by various Authors. W.H.O. Monograph Series No. 20. London : H.M. Stationery Office. 1954. Pp. 224. 17s. 6d.

This monograph presents without question the most complete and up-to-date summary of the present position in influenza research that is now available.

It is perhaps a pity that more space is not devoted to the practical aspects of laboratory methods, and more detail might well be given regarding the preparation of influenza vaccines. The monograph has, however, been kept within reasonable limits—223 pages—and any omissions are quite compensated for by the excellent bibliography.

Many aspects of the influenza problems are dealt with—epidemiology, distribution of antibody in populations, and recent trends in mortality. The nature and multiplication of the virus and laboratory methods for study are also included. The control of the disease is described at length.

Of particular interest to most medical readers will be the section on "Epidemiology of Influenza," where the recent history of the disease is fascinatingly recounted by Dr. Andrews. Most sections of the work are likely to be rather too specialized for the general reader, and indeed there are likely to be few virologists who would fail to find something new of interest in these pages.

This is an authoritative work which should certainly find a place on the shelves of all those interested in the laboratory aspects or control of influenza, and at its very reasonable price—17s. 6d.—it should prove most attractive.

J. A. H. B.

DISEASES OF THE NOSE, THROAT AND EAR. F. W. Watkyn-Thomas, F.R.C.S. (Eng.) (Editor). London: H. K. Lewis. 1953. Pp. xvi + 880, 367 illus. (incl. 22 coloured). £5 10s.

This is a single-volume work by some eleven contributors. The preface traces its ancestry and lineage from Herbert Tilley's "Handbook" of a generation back.

This new work is compact, concise, and to the point. There is a vast fund of correlated material for the postgraduate student in the 880 pages. Of particular appeal is the section devoted to aural physiology, pathology, and treatment. The chapter on Facial Palsy is outstanding, as is that on the examination of hearing.

This is a balanced contribution to British oto-laryngology and one which is confidently recommended to those studying for higher qualifications in the specialty.

H. N. P.

RADIATIONS AND LIVING CELLS. By F. G. Spear, M.D., D.M.R.E. London: Chapman & Hall Ltd. 1953. Pp. xii+222, 60 illus. 18s.

This is an excellent small book in the *Frontiers of Science* series. It is based on notes for candidates for the Diploma in Radiology, but should have a much wider appeal.

It can be recommended to Service medical officers who wish to bring themselves up to date on the complex subject of Radiation Biology, which has assumed so much importance in military medicine since August, 1945.

It would be interesting to know how many who have not read this book are aware that at a time when no concerted action for civilian protection had been undertaken, the first definite instructions as to the safety of military personnel were issued by the X-ray Committee of the War Office.

A. R. T. L.

SPOT DIAGNOSIS WITH NOTES ON THERAPY. Vol. I. Compiled by the Editors of *Medicine Illustrated*. London: Harvey & Blythe Ltd. 1954. Pp. 128, 102 photographs. 17s. 6d.

The more we see and the more often we see it makes for familiarity, accuracy and competence. If we cannot see the actual cases or specimens the next best is to be able to feast our eyes repeatedly on lifelike photographs in colour and in "3D," thus acquiring the familiarity of repetition. "Spot Diagnosis" has this idea in mind and when it is fully developed in a much enlarged volume it will be eagerly sought after by medical students, general practitioners and candidates for higher qualifications. Part Two is unnecessary in these days of rapid therapeutic advances and readily available medical literature on therapy.

Volume I contains much of interest and can be recommended for those embarking on the "Finals" and as a refresher for those on the Senior Course at the R.A.M. College.

J. M.-D.

SUDAN DOCTOR. By Leonard Bousfield, M.D. London: Christopher Johnson. 1954. Pp. 201, 15 photographs, 1 map. 15s.

This is a story of reminiscences romping through school days, Cambridge, the London Hospital, the Corps (with service with Sir William Leishman), a secondment to the Egyptian Army, and finally his story of his life in the Sudan Medical Service.

C. M. M.

TREPONEMATOSES: A World Problem. By T. Guthe, M.D., M.P.H., and R. R. Willcox, M.D. W.H.O., Geneva. 1954. Pp. 77, 27 illus. 3s. 6d.

The first article deals in some detail with the extent of the problem of a group of diseases caused by infection with closely related treponemes, affecting a large proportion of the world's population. An estimate that twenty million cases of venereal syphilis and fifty million cases of yaws exist throughout the world, gives some idea of the tremendous problem which must be faced in tackling any control programme.

The knowledge that under suitable environmental conditions the treponemes of venereal syphilis can cause infection non-venereally, particularly in children, as illustrated by the large number of cases of non-venereal syphilis in Bosnia, and the probability that the treponemes of yaws, pinta and syphilis are closely related, calls for special consideration in view of the ease of modern methods of travel and communications.

Bejel, a treponematosis very closely related to endemic syphilis and other treponematoses described under different names throughout the world, gives further evidence of the magnitude of the world-wide problem. The incapacitating results of the diseases if left untreated and economic loss involved are discussed.

In the second article new methods of control are described. Penicillin is

the drug of choice because it is easily available, relatively cheap, almost non-toxic and enables treatment to be given on an ambulatory basis. P.A.M. is the preparation favoured and the recommended dosage is 1.2 mega units for endemic treponematoses, 2.4 mega units for primary syphilis and 4.8 mega units for cases in the secondary stage of syphilis.

The reasons why mass treatment campaigns are necessary and the methods used are explained.

The later chapters give details of the work in the control of treponematoses already carried out by the World Health Organization in various parts of the world, and also show the importance which should be given to methods to stimulate research in the clinical and laboratory fields.

The publication is well illustrated with excellent photographs and tables.

B. L.

**OUR NATIONAL ILL-HEALTH SERVICE.** By Sir Sheldon F. Dudley, *K.C.B., F.R.S.* London: Watts & Co. 1954. Pp. xiv+225. 15s.

This is a stimulating and controversial book, written to elaborate its distinguished author's thesis that our National Health Service puts excessive emphasis upon curative, at the expense of preventive, medicine.

Sir Sheldon Dudley will find the medical officers of the fighting services an audience largely in agreement with his views, though differing, perhaps, in detail; this agreement is understandable when the lead given by the Navy and Army in preventive medicine is remembered. It is to be hoped that his book will find its way into the hands, and minds, of those influential civilians whom the author robustly stigmatizes as "these professors of ill-health."

Readers of this Journal will naturally turn with most interest to the chapter, "The Army's Struggle for Hygiene Discipline," in which the author produces strong support for his statement that the tragedy of preventive medicine is that no one believes in its necessity till a disaster occurs as a result of its neglect. Few Army medical officers of experience would fail to agree.

Not all the statements in this chapter are so easily defensible. The puritan, Cotton Mather, would be surprised and indignant to find himself described on page 130 as "Canon" Mather. So would the hundreds of nursing sisters who served in hospital ships in World War I at the implication that the Army did not employ women in this capacity until the last war.

The book is short, easy to read, stimulative of thought and, sometimes, of disagreement; it deserves a wide circulation.

R. J. N.

**PHARMACOLOGY.** By J. H. Gaddum, *Sc.D., F.R.S., M.R.C.S., L.R.C.P.*, Professor of Pharmacology in the University of Edinburgh. 4th Edition. 1953. Oxford University Press. Pp. xviii+562, 89 illus. 35s.

In the four years that have passed since the third edition of this book, rapid advances in therapeutics have taken place and Professor Gaddum has ensured

that the reader is thoroughly acquainted with them. There has been a very thorough revision and few pages remain as they were. Pharmacology is often regarded as a dull subject, but Professor Gaddum makes it live. The physiologist, the biochemist, the toxicologist and the pathologist will find much to interest them, but the book will be most useful to those engaged in treating the sick.

There are chapters on diet, vitamins, hormones, chemotherapy; a minor criticism is that the chapter on general pharmacology would be better placed at the beginning rather than at the end of the book.

The production and printing are excellent. There are 18 new figures which are very well produced.

R. J. G. M.

**ATOMIC MEDICINE.** Edited by Charles F. Behrens, M.D. London: Baillière, Tindall & Cox Ltd. (2nd Edition). 1953. Pp. xiv+450. 100 illus. 84s.

The rapid expansion which has taken place in this new field is well illustrated by the appearance of this second edition of Admiral Behrens' comprehensive volume.

This book is a mine of information for those who wish to study all the medical problems produced by man's "mastery" of the atom. The number and variety of these problems are indicated by the titles of the twenty-two different chapters, written by twenty different contributors.

This is hardly a book to read straight through, but is one which should be on the shelf of anyone who wishes to keep informed on this vast and rapidly expanding field of medical knowledge.

There is a useful index and there are three appendices. Each of the chapters is followed by a comprehensive bibliography.

This is a very good reference book.

A. R. T. L.

**DISEASES OF THE SKIN.** Edited by R. M. B. MacKenna. 5th Edition. London: Baillière, Tindall & Cox. Pp. 215. 42s.

MacKenna's *Diseases of the Skin* needs no introduction, and this completely revised and reset fifth edition is designed to meet the requirements of the student and practitioner. All ordinary skin affections are dealt with fully, with sufficient details to enable differential diagnosis to be made, and there are notes on the rarer conditions. The results of recent research and advances in treatment have been incorporated and a notable feature of the book is the large number of prescriptions provided.

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W. G. G.



EXPERT COMMITTEE ON ENVIRONMENTAL SANITATION, Third Report. W.H.O. Tech. Rep. Ser. No. 77. Geneva, 1954. Pp. 25. 1s. 9d.

This report presents an excellent general review of the situation without attempting to recommend any detailed measures or give technical advice, which, they very rightly say, should be made available in the form of manuals for sanitary practice which should be prepared and published by W.H.O. The various pitfalls and difficulties which may arise in instituting an environmental sanitation programme in underdeveloped countries are clearly explained, and they stress the fact that sanitation must be part of a general plan of community improvement which aims at the provision of an improved standard of well-being and living conditions.

Coming down to concrete recommendations, the Committee states that the first basic steps should be to—

- (a) provide adequate supplies of safe drinking water ;
- (b) provide for the safe disposal of human excreta ; and
- (c) control the insect and animal vectors of disease where they are of significant importance.

Stress is also laid on the value of health education of the people, local participation in sanitation programmes, the inclusion of sanitary engineers in the team, and close co-operation with other experts in such fields as nutrition, agriculture, animal husbandry, economics and sociology. W. S. M.

THE SULPHONAMIDES AND ANTIBIOTICS IN MAN AND ANIMALS. By J. Stewart Lawrence and John Francis, with the assistance of A. Sorsby and Philip G. Scott. London : H. K. Lewis. 1954. Pp. xii+482 ; 39 illus. 42s.

This book gives an excellent review of a rapidly changing subject. It is remarkable that a textbook of this kind should be so up to date. The sulphonamides are fully covered, including a very good chapter on pharmacology and choice of compounds. It is useful to find a chapter on the sulphones, thiosemicarbazones and *p*-amino salicylic acid and an appendix on the nicotinic acid derivatives.

The antibiotics are first discussed separately, then each infection in turn and finally regional diseases. This section of the book will be found most valuable in practice.

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PLAGUE. By R. Pollitzer, M.D. W.H.O., Geneva, 1954. Pp. 698, 79 illus. (incl. 40 original drawings, 2 folding maps and 2 coloured plates). £3 5s. (clothbound), £3 (paper bound).

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- Alfred Hospital, Melbourne.** Clinical Reports. Editorial Committee, Alfred Hospital (Incorporated). Pp. 115. Numerous illus.
- Undernutrition and Malnutrition in Mothers, Infants and Children (3rd Report of Joint F.A.O./W.H.O. Expert Committee on Nutrition).** W.H.O. Tech. Rep. Ser. No. 72. Dec., 1953. Pp. 30. 1s. 6d.
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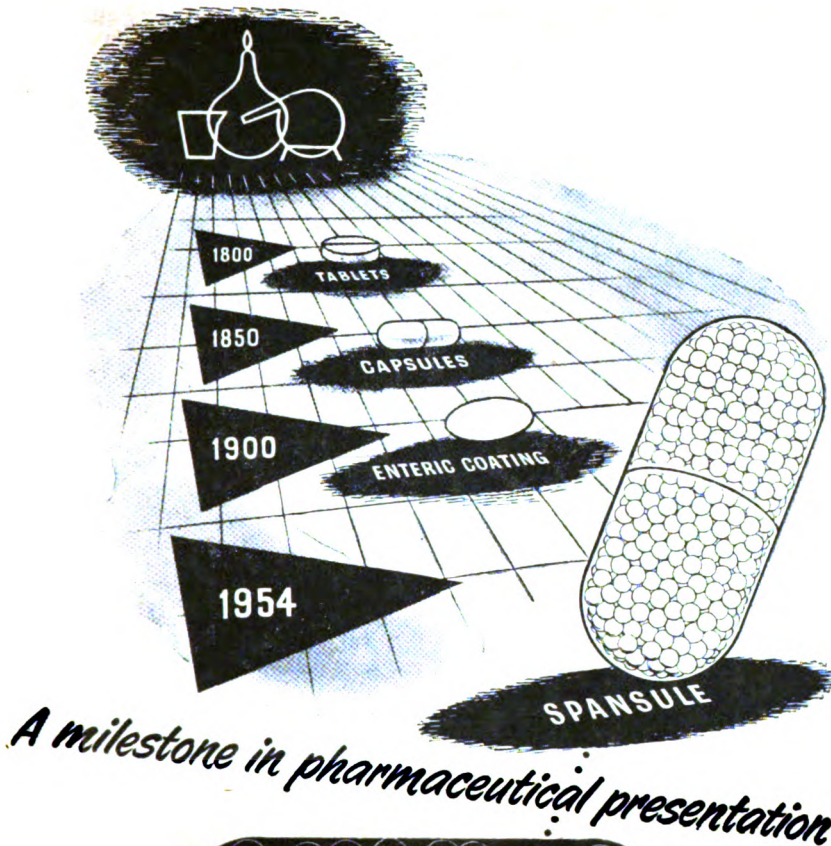
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THE

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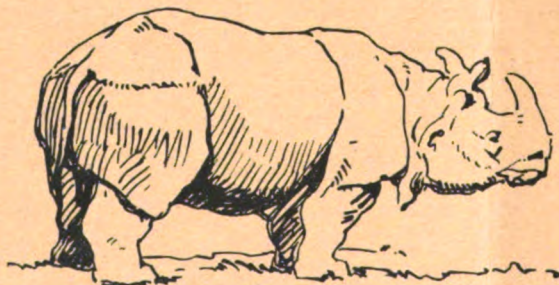
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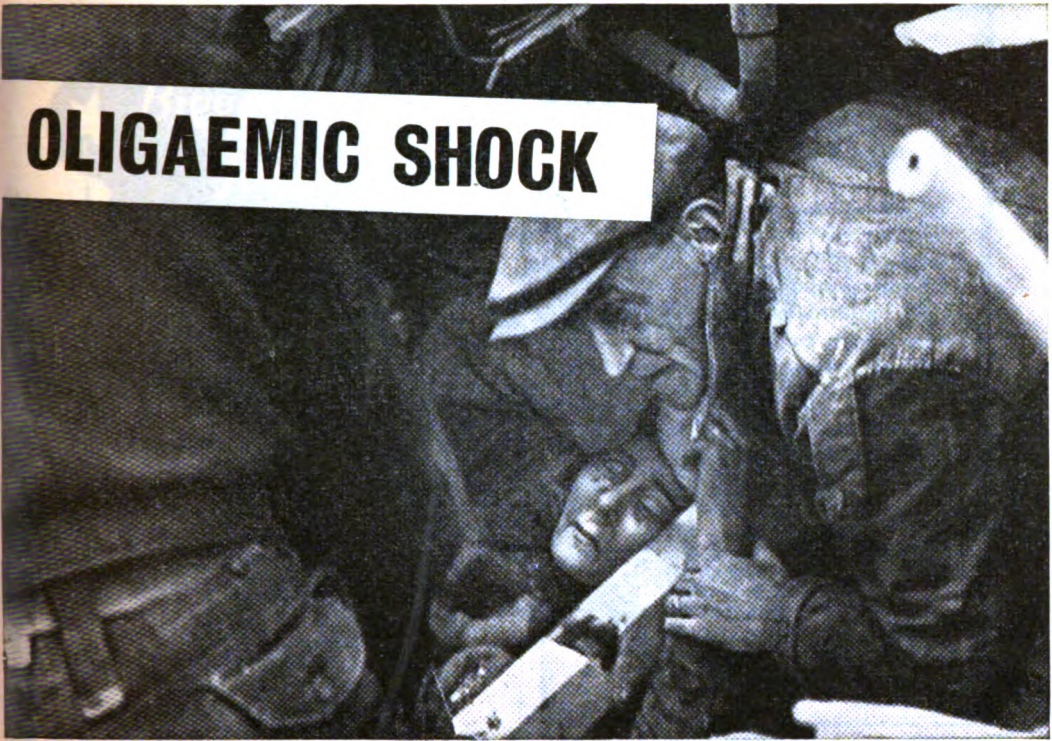
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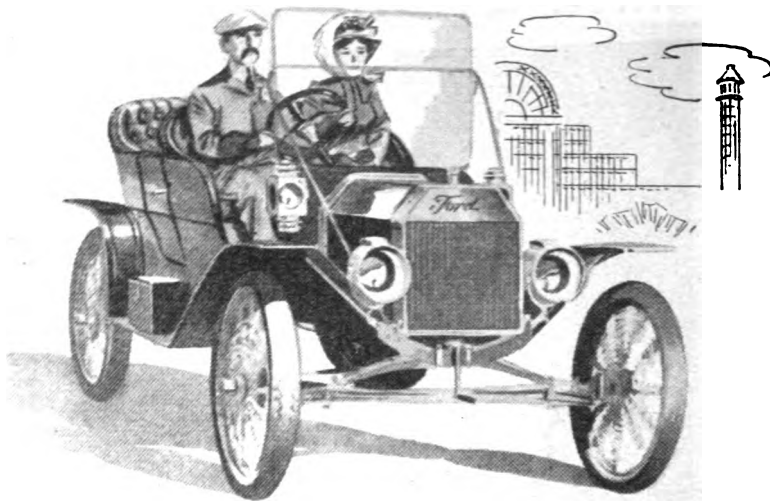
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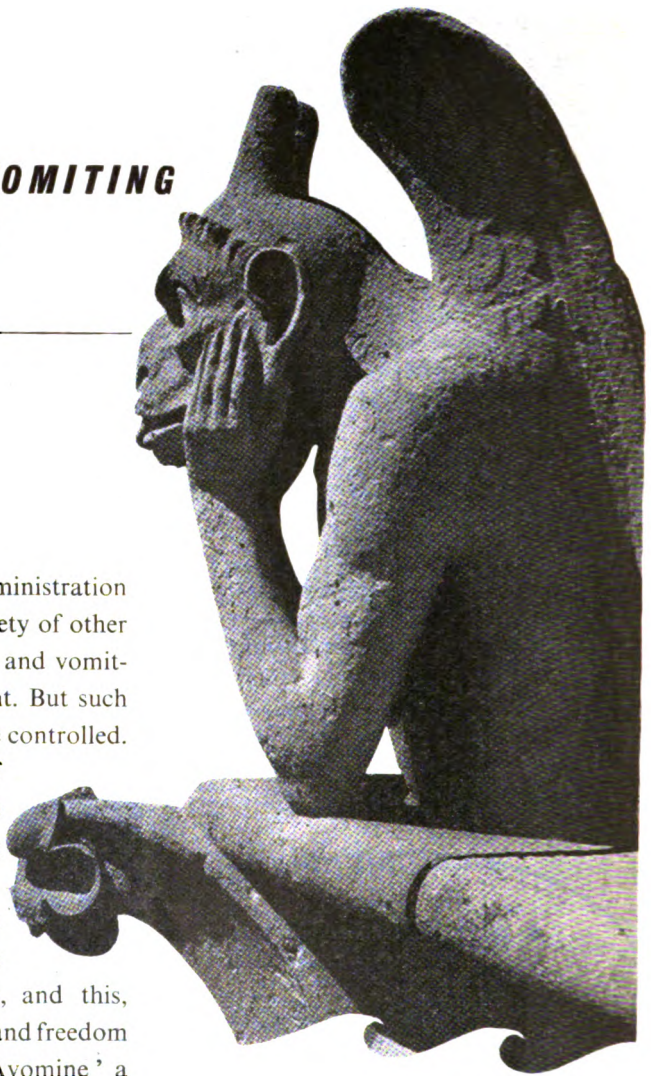
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# **Journal** of the **Royal Army Medical Corps**

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## **FOREWORD**

BY

**LIEUT.-GENERAL SIR FREDERICK HARRIS,**  
**K.B.E., C.B., M.C., Q.H.S., M.B., D.G.A.M.S.**

ALTHOUGH the early years of my service in the R.A.M.C. overlapped the last year or two of that of David Bruce, I never had the honour of meeting him or even seeing him ; but I have often heard about him and his characteristics from those officers who had served with him. It was always obvious in these conversations in what respect and esteem he was held and with what pride he was regarded throughout the Corps. His career has indeed been an inspiration and an incentive to those who followed after him. I well remember the pride I felt shortly after joining the R.A.M.C. to learn that General Bruce of the Army Medical Services was in fact the famous Bruce of sleeping sickness and Malta fever fame.

Bruce was born in Melbourne on 29th May, 1855, of Scottish parents ; and it is a happy coincidence that 1855 was the year in which pathology was first officially established in the Army. At five years of age he returned with his parents to Scotland, where he received his schooling and his university education. He was a strong, robust, active boy of splendid physique ; and it is said that at the age of fourteen he wanted to become a professional boxer. Fortunately for tropical medicine, this youthful ambition was not achieved ; instead he graduated in medicine in 1881, and two years later joined the Army Medical Department.

Bruce thus joined the Army at the beginning of the golden age of research in tropical medicine ; and, by being in the Army, he had the opportunity of serving in the tropics and sub-tropics. And what wonderful use Bruce made of his opportunities ! Between the years 1884 and 1905 he discovered the causal

organism (*Brucella melitensis*) of the so-called Malta fever ; proved that this causal organism was carried in the milk of goats ; discovered that *Trypanosoma brucei* was the causal organism of the group of diseases among animals then called the tsetse-fly diseases ; proved that it was carried from one animal to another by the tsetse-fly (Bruce was thus the first to show that an insect could carry a protozoan which produced disease) ; and showed that sleeping sickness in humans was caused by a trypanosome carried by the tsetse-fly from the sick to the healthy. But his research work did not end in 1905. Between then and 1919 he carried out further valuable research into the causation of disease by trypanosomes and into the origin of trench fever and tetanus. It has fallen to the lot of few men to have achieved so much in the investigation into the causation of disease. He is indeed a worthy member of that illustrious group, which includes himself, Sir Patrick Manson, Sir Ronald Ross and Sir William Leishman, which can be said to have laid the foundations of tropical medicine. It is with pride that it is recalled that two of them were members of the Royal Army Medical Corps and one of the Indian Medical Service.

Bruce was a great pioneer in medical research, and his principles are well worthy of study by the young research worker of today. He was essentially an experimenter who used simple, direct, logical methods and who reported his findings in clear, simple, convincing language. He was a forceful personality who held clear-cut views—he did not suffer fools gladly, but he dearly loved his friends. He was a most lovable character and a jovial human being.

During his career he received numerous honours, both civil and military. Indeed, the special entries in his Army record of service are so numerous that they far overflow the normal space allotted to them. They begin in 1883 when his name was brought to the notice of the Secretary of State by the professors of the Army Medical School, Netley, as a young officer of great merit and promise, and they end in 1918 with the award of the K.C.B. He was gazetted brevet colonel in 1903 for scientific research—the first ever to be given such an award. Similarly he was the first to be promoted surgeon-general for his scientific services. One entry which throws a sidelight on his forceful and human character records that he was “reported for using strong language to the railway officials at Portsmouth” on his return from one of his trips to Africa. The reprimand which duly followed in no way affected his subsequent career. His name is commemorated today in the Army by the beautiful case of medals which he left in his will to the R.A.M.C. Headquarter Mess, Millbank ; by the David Bruce Military Hospital, Malta ; and by the David Bruce Laboratories, Everleigh.

His civil awards were numerous and include among many others the official thanks of many Governments, and such high honours as the F.R.S., F.R.C.P., Chairman of the Governing Body of the Lister Institute, and the fellowship of many learned societies.

But the greatest memento, and that which he himself would have most appreciated, is that he clearly lit the way to the eventual extermination of tropical disease among the officers and men of the Army which he served so well.

## SIR DAVID BRUCE

### AN APPRECIATION

BY

**Professor W. J. TULLOCH, M.D.**

*University of St. Andrews*

IT is, one feels, not sufficiently known how much the Army Medical Service of this country has contributed to the prevention of communicable disease. The British people, and indeed even the profession of Medicine in this country, within the space of a lifetime, is already tending to forget the debt of gratitude which mankind owes to those brilliant pioneers in the field of preventive medicine—Bruce, Horrocks and Leishman.

This year marks the centenary of the birth of the first of them—David Bruce—and it is in a spirit of “filial faith” that the writer pens these notes of appreciation of his qualities as a man and of his distinction as an investigator. It is difficult, however, to pay adequate tribute to one whose life was so full, whose activities were so varied, and whose character presented so many brilliant facets: this tribute must then of necessity be inadequate, but that shortcoming is mitigated by its sincerity.

It is peculiarly appropriate that in the Dictionary of National Biography—1931 to 1940—the section devoted to David Bruce is preceded by that dealing with G. C. Bruce, the soldier and mountaineer, and is followed by an account of one distinguished in literature and in administration—John Buchan.

David Bruce shared with his namesake the mountaineer the frame of an athlete, the capacity to endure physical effort, the courage to meet and overcome frustration and, above all, the urge to achieve. He was also possessed of the attributes of the eminent author, exhibiting a clarity of thought and of expression which has made his contributions to scientific literature models of lucidity. He recalls to one three rectorial addresses delivered at the University of St. Andrews, the first by J. M. Barrie on “Courage,” the second by Nansen on the “Spirit of Adventure” and the third by Grenfell of Labrador on “Service”: for that trinity of qualities constituted the mainspring of Bruce’s life.

Like that giant in the field of natural philosophy, Lord Rutherford, Bruce was a “son of the south,” being born at Melbourne on 29th May, 1855, the offspring of a Scots engineer who had gone to Australia to deal in mining machinery during the gold rush. His parents returned to Scotland five years after his birth and his boyhood days were spent in Stirling, at the High School of which he received his preliminary education and, even as a schoolboy, he gained distinction in the study of natural history. This interest in living things in their natural surroundings—the hallmark of the true “naturalist”—influenced him throughout his life and was the sure foundation upon which he built his reputation as an investigator in the field of medicine, for notwithstanding his achievements in medical research, he realized that medicine was only a particular, and restricted,

branch of general biology. He had the good fortune to be born before the days of ultra specialization and the good sense to take a broad view of the problems which he was called upon to solve.

He left school at the age of fourteen to enter upon a business career and was for some time engaged in banking. He tolerated the life of the business man in training for seven years, but business was certainly not his niche in life. His innate hankering after the study of living things induced him in 1876—he was then twenty-one years of age—to enter the University of Edinburgh as a student of biology. At Edinburgh one of his closest friends was the late Sir D'Arcy W. Thompson, the eminent zoologist, and it was pure chance—the advice of another fellow undergraduate who was a student of medicine—that Bruce renounced zoology as his special study and entered the medical faculty. As an undergraduate he was not brilliant in the academic sense, but he showed those qualities—a critical outlook and a maturity of thought—that far surpass in value mere factual knowledge. Graduating M.B., C.M., in 1881, he was in general practice as an assistant in Reigate for two years, when he entered the Army Medical Service, being placed first in the list of Netley candidates in 1883. He received his first commission on 4th August of that year.

In some ways he was favoured by fortune, being more than once “in the right place at the right time”—in Malta, in Zululand and in Uganda—but fortune is the servant only of those who grasp the opportunities presented to them, and there was no hesitation in Bruce's grasp. In one regard he was specially favoured by providence—his choice of a life's companion. While in Reigate he married Mary Elizabeth Steele, who shared the rigours of his life, was his colleague as well as his helpmate, assisted in all his scientific investigations—indeed she amplified some of them—recorded with consummate artistry the phases in the development of trypanosomes, and designed as well as executed the diagrams which made his published works so easy to comprehend. It may be said, and he would have been the first to acknowledge it, that Sir David owed to Lady Bruce the greater part of his success. There was a perfect mutual sympathy between them and her encouragement was his constant inspiration, as also was her criticism. Headstrong and self-willed, Bruce would not brook criticism from many, but he was ever ready to give ear to her advice and always profited from so doing.

Lady Bruce was truly a remarkable woman—a brilliant laboratory worker, a scientist, an artist and, in dealing with her husband, a very sound psychologist, as is shown by the following incident: On one occasion a junior officer who wished to consult Sir David was told by his secretary that “the General was very ill.” The young man asked if he might see Lady Bruce, who at once sent him to Sir David's room, and was surprised to find that the General was *not* very ill; indeed, although in bed, he was in excellent form. The visitor completed his business and on leaving thanked Lady Bruce for her kindness. Intrigued, however, by the discrepancy between what had been conveyed by the secretary and the actual condition of his commanding officer, he said, “Lady Bruce, if it is not an indiscretion, may I ask what is the nature of Sir David's indisposition?” to receive the reply, “Well, you see, I do all the illustrations for his publications

and he has got too far ahead of me in the paper he is preparing just now, so I just put a thermometer in his mouth and said, 'David, you have got a temperature !' "

It would seem that their sympathy was such that, united throughout their active lives, they should be united even in death, for Sir David, who died on 27th November, 1931, survived her by only four days.

It is not possible in a short appreciation of this kind to do justice to the work of Bruce, as from his entry to the Service until he was finally retired in 1919—a period of thirty-six years—he was engaged mainly in conducting research, his contributions to medical literature numbering over 150 ; and in addition to his better-known works on Malta fever, trypanosomiasis, tetanus and trench fever, dealt with a diversity of subjects including cholera, asylum dysentery, plague and dumdum fever, as well as infections of domestic and wild animals.

Early in his career he showed a bent towards pathology, and was at the beginning of his career in the Service "brought to the notice of the Secretary of State for War by the Professors of the Army Medical School, Netley, as a young officer of great merit and promise. Took highest place in the examination for Pathology and gained 2nd Montefiore Prize."

The Montefiore Prize was awarded for distinction in Surgery, and it was probable that, had he chosen to be a surgeon, Bruce would have attained the same distinction in surgery as he did in preventive medicine. His flair for surgery stood him in good stead at the siege of Ladysmith, when he was called upon to undertake a very large share, indeed almost all, of the surgical operative work under conditions of great difficulty. He performed these duties as a surgeon with the same enthusiasm as marked his other activities, and to hear him in later years recounting with pride his achievements in this field made one feel that a great surgeon was possibly lost in the greater biologist.

Within seven months of receiving his commission, Bruce was posted to Malta and, with the exception of some months when he was with troops in Egypt, remained a member of the garrison of that island until 1888 : it was during this period that he carried out his pioneer investigations on undulant (Malta) fever.

Although much information had already been garnered concerning the epidemiology of Malta fever, nothing was known concerning its cause : Bruce set himself the task of elucidating its ætiology. While very well equipped as a man to deal with this problem, the material resources at his disposal were meagre ; but with the able assistance and encouragement of his wife, the technical difficulties which beset his path were overcome, and in 1886 he demonstrated, both microscopically and by culture, the presence of the micro-organism now called *Brucella melitensis* in the spleen of fatal cases of the malady. He was, however, a perfectionist and could not accept the mere demonstration of the organism in the tissues of cases as adequate evidence of its relationship to the disease. He therefore attempted to produce the condition experimentally, but in the case of "ordinary" laboratory animals, such as mice, guinea-pigs and rabbits, the results obtained were entirely negative. Many would have carried the investigation no further, but, being a true naturalist, he realized that none of the species he employed might have been susceptible. Success was finally achieved when

imported monkeys were used as test animals, and his findings were subsequently corroborated by the occurrence of several accidental infections of man acquired in the laboratory, one of which proved fatal.

It is of interest to speculate on what might have happened had he examined, for example, the spleens of the experimental guinea-pigs by cultural methods, because this would have revealed at an early stage in the history of medical bacteriology the occurrence of unapparent infections which, it is now appreciated, play so important a role in epidemiology.

During this period two factors influenced Bruce's future career. The first was that during the time he was engaged in these early studies on undulant fever, Sir Walter Hely-Hutchinson was Lieutenant-Governor of Malta, and it was he who later, as Governor of Natal, had Bruce seconded to investigate nagana. The second was that late in 1888 he and Lady Bruce worked in Koch's laboratory and acquired, from that master, a perfection in technique which characterized all their work.

For approximately five years he held the post of Assistant Professor of Pathology at Netley, and as a teacher he stressed the experimental and bacteriological aspects of his subject, stimulating interest therein not only in the Service and in this country but throughout the world.

The year 1894 saw him on his way to South Africa on field service. Soon after his arrival in Natal—he was quartered at Pietermaritzburg—a very severe outbreak of nagana, causing grave economic stress both to native stock raisers and to white settlers, occurred in Northern Zululand. It was then that Sir Walter Hely-Hutchinson, recalling the investigation of undulant fever, used his good offices to have Bruce seconded in order that he might investigate this disease. The period of secondment was only two months, but in five to six weeks, although living under quite primitive conditions, he, with the untiring assistance of his wife, established a positive correlation between the malady and the presence of a characteristic trypanosome in the blood of the affected animals, the finding being published in December, 1895, as a *Preliminary Report on Tsetse Fly Disease or Nagana in Zululand*.

Meanwhile he had been promoted Major and was again seconded to resume the study of nagana. He returned to Zululand with his wife in 1896, and together they were able to give undivided attention to their research for a period of two years; these years were full of interest, incident and achievement.

This devoted couple during these years lived and worked under truly primitive conditions; their housing differed in no way from that of the native population, for food they had to rely on their capabilities as hunters, and, perhaps particularly difficult to bear, they were cut off from contact with other Europeans by a wide belt of bush.

The absence of amenities did not damp their enthusiasm, and by a brilliant series of observations they proved not only that nagana was caused by *Trypanosoma brucei* but that it was propagated by the bite of *Glossina morsitans*, which acted not merely as a vector but as a true arthropod host of that protozoon. It is the hall-mark of good research workers that they ask of nature only simple

questions so that unequivocal answers may be obtained. This team exhibited that quality both in the planning and in the execution of their experiments to a degree that was more than masterly ; it was magnificent, and allowed of incontrovertible conclusions being drawn from their work.

Many regard Bruce's investigation of nagana as his most notable achievement : it was certainly a model of how research should be prosecuted and the results presented. It constituted not merely a great advance in preventive medicine, but was indeed a major contribution to the study of general biology, and rightly earned for him the honour of being elected a Fellow of the Royal Society (1899). This election took place *in absentia*, for it was at this time that his activities were devoted to operative surgery at the siege of Ladysmith.

At the beginning of the century, when the South African War was drawing to its close, he was appointed a member of the Committee of Enquiry set up to investigate enteric fever and dysentery in the field. He was specially promoted Lieutenant-Colonel in 1903, and two years later was made a member of the Army Medical Services Advisory Board, upon which he served until 1911, although during much of that time he was absent from this country, being engaged on special service, particularly the study of sleeping sickness and the further investigation of undulant fever in Malta.

At this time sleeping sickness, the ætiology of which was then unknown, had become a scourge to the people of Uganda, and in 1903 the Royal Society, having appointed a Commission to investigate the malady, requested that Bruce be seconded to assist in its labours. This was a fortunate choice and good fortune was again the handmaiden of Bruce, for soon after he and his wife arrived at Entebbe, Castellani showed to him preparations of trypanosomes which he (Castellani) had found in the cerebro-spinal fluid of cases of the disease.

At this time to show a trypanosome to Bruce was like putting a hound upon a strong scent : with indomitable energy he followed this scent and very soon was able to show that, while the protozoon was often present in the thecal fluid of cases of sleeping sickness, it was never present in that of normal people. It was the story of nagana over again, for within a very short time he showed that the presence of this trypanosome was characteristic of the malady.

In view of his experience with nagana he naturally regarded it as not improbable that infection was transmitted by the tsetse fly (*Glossina morsitans*), but that insect was unknown in the areas where sleeping sickness was prevalent. Flies which resembled *Glossina morsitans* were, however, observed and captured by Lady Bruce, and these proved to be another variety of *Glossina*—*Glossina palpalis*. Here the instinct of the true naturalist again stood Bruce in good stead ; making use of the tribal system of government—based essentially on a feudal system—he was able, by enlisting the help of chiefs, sub-chiefs and others, rapidly to obtain information concerning the distribution both of the kind of fly observed by Lady Bruce and of the cases of sleeping sickness : the distribution of these coincided. There was, then, more than a suggestion that human trypanosomiasis was propagated in the same manner as nagana, and this was proved by



the successful transmission of infection from human cases to experimental monkeys by the bite of this fly.

It is remarkable, and says much for the energy and acumen of David Bruce, that these fundamental observations were completed in the short space of only six months—19th February, 1903, to 27th September, 1903.

It is sometimes assumed, quite wrongly, that when the causal agent of a communicable disease has been defined, the prevention or cure of the condition for which it is responsible will follow almost automatically; but in 1904, seventeen years having elapsed since Bruce first established that *Brucella melitensis* was responsible for Malta fever, the disease was as prevalent as ever and constituted the major problem of military and naval medicine in the Mediterranean at that time.

Because of this Bruce returned to the study of Malta fever, having been appointed head of a Commission set up by the Royal Society to investigate means of preventing it.

The year 1904 is notable in the history of medicine, for during that year was revealed the existence of unapparent infections—in the case of enteric fever by Koch and his co-workers and in that of undulant fever by Bruce and his associates. The discovery of unapparent infections—*i.e.*, the carrier state—was one of the greatest advances ever made in the study of epidemiology.

It is difficult to realize that only fifty years ago the term “carrier,” as applied to infectious disease, a term which today is commonplace, was unknown. It was in 1904 that Koch instituted an investigation of enteric fever to determine whether his opinion that the source of this disease is man himself was or was not valid. The validity of Koch’s view was established by Drigalski, so that the carrier state in enteric fever was discovered and the reservoir of infection defined. Of equal importance were the corresponding observations of Bruce and Zammit which showed that unapparent infection of goats was the mechanism whereby the prevalence of Malta fever was maintained. In a practical sense Bruce’s work on undulant fever was of more immediate value than that on enteric, for it is obviously less difficult to deal with an “animal carrier” than with a “human carrier.”

Although goats had been suspected by Bruce to play some part in the transmission of the disease, the work of the Commission proceeded but slowly at the outset, mainly because attempts to infect these animals seemed to fail. An observation, however, by Dr. Zammit that the blood of a goat to which he had fed a culture of the organism contained agglutinating antibodies thereto (May, 1905) gave a most valuable clue, indicating the possibility that infection of goats with the organism of Malta fever might be unapparent. There was no evidence that this animal had been ill as a result of the infection and, therefore, in view of what was known concerning the agglutination reaction as a diagnostic procedure in other infections, it could only be concluded either that this goat was, or had been, infected, or that goats as a species were possessed of natural agglutinating antibodies to this organism. Here was a possibility demanding immediate and

energetic inquiry ; the problem was dealt with vigorously and the work was now inspired by hope.

In surveying a sampling of the caprine population of the island it was found that a high percentage—40 to 50 per cent.—of the goats gave positive agglutination reactions with *Brucella*, a finding which clearly indicated that it was not an innate quality of goats to possess natural antibodies to the organism, but that the antibodies were called forth in response to infection. Moreover, the number of animals which gave such positive results was such that among them there must have been a widespread infection, and therefore at any given time it should be possible to recover the organism from some of them.

The next phase of the work was to determine in which tissues of the goats the micro-organism was present and by which route it left them. In this Bruce's breadth of view as a biologist proved as valuable as did his drive in prosecuting the investigation, and it was soon demonstrated that about 10 per cent. of the goats supplying milk to the garrison were secreting that fluid heavily infected with the causal agent of the disease.

The way was now clear for positive action, and raw goats' milk was discontinued in the dietary of the garrison with most satisfactory results. This measure was introduced in July, 1906, and in the period April to June of that year the incidence of the disease was 42.5 per thousand ; this fell to 15.4 per thousand in the third quarter—July to September—and to 14.5 between October and December. The corresponding figures for the preceding quinquennium were : first quarter 23.5, second quarter 32.1, third quarter 58.9 and fourth quarter 35.3. The figures for naval ratings were equally striking, there being 245 cases in 1905 and only 12 in 1907.

The conquest of Malta fever is perhaps the most striking example of the application of laboratory methods to the control of communicable disease : it has stood the test of time and is one of the really unequivocal successes of preventive medicine. Bruce was justly proud of his achievement, his own comment being that "the disease had been blotted out at a single blow."

The value of this work was self-evident, and in recognition of it he was appointed C.B. in 1905 and in the same year was awarded the Royal Medal of the Royal Society, while in 1907 he was "highly commended by the Royal Society for services as Chairman of the Malta Fever Commission," and in 1908 he received the honour of knighthood.

After conducting this work on Malta fever, Bruce remained at home until 1908, during which time he acted as Editor of this Journal. He then returned to Uganda for about two years to continue the study of human trypanosomiasis. These were fruitful years as he and his associates were able clearly to define the role of *Glossina palpalis* as a true arthropod host, in contrast to a mechanical vector of the parasite of sleeping sickness. Evidence was also obtained that both domestic and wild animals could, although showing no ill effects, act as vertebrate hosts of the trypanosome responsible for the human illness. This was yet another, and a tragic, example of the importance of unapparent infection, for it is virtually impossible to control a malady maintained by such a variety of potential carriers.

In view of these fundamental contributions to our knowledge of human trypanosomiasis in Uganda, it was but natural that, when the same condition was recognized as occurring in Nyasaland, Bruce was called upon to study the malady in that territory. He was, therefore, appointed in 1911 as Director of a Commission set up by the Royal Society to investigate any relationship that might exist between human trypanosomiasis and that of animals, both domestic and wild, in Nyasaland. The problem which this presented to the Commission was of great complexity because the arthropod responsible for the transmission of the causal agent in the human cases—*Trypanosoma rhodesiense*—was *Glossina morsitans*, which is also the insect host of the parasite of nagana—*Trypanosoma brucei*—and of at least two other species encountered in domestic animals.

The transmission of nagana and of Rhodesian human trypanosomiasis by the same insect was not, however, the only difficulty encountered in this work, for *T. brucei* could not be distinguished morphologically from *T. rhodesiense* and no crucial distinguishing test was found. The patience and industry which Lady Bruce showed in recording accurately the morphology of these parasites, whose relationship still remains a subject of controversy, was remarkable. It is averred that on one occasion, still hoping that some differential feature might be revealed if a sufficient number of parasites were examined, her husband said, "Here, Mary, do another ten thousand"—a truly formidable task in a tropical climate, for the work involved that that number of trypanosomes be examined and each accurately sketched.

It is not known yet whether Rhodesian sleeping sickness is due to a variant of *T. brucei* or to a different species: Bruce's own view was that these two protozoa were the same, modified possibly by transference through different animal hosts.

In recognition of his services to science, Bruce was in 1912 specially promoted to the rank of Surgeon-General.

Recalled home on the outbreak of the war of 1914-1918, he was appointed Commandant of the Royal Army Medical College; but his main interest continued to be trypanosomes, and one felt that he did not regard the First World War as the tragedy it was to so many but rather as an unavoidable nuisance which interfered with his work in Nyasaland. German and Portuguese investigators had inoculated blood from nine different sources, containing *T. brucei*, into 133 human volunteers without inducing an infection of these. His comment was: "These numbers are far too small and if my work had not been interfered with by this war I should have tried it out on thousands. That would have settled the question of whether *T. brucei* and *T. rhodesiense* are, or are not, the same."

As Commandant of the Royal Army Medical College, his knowledge and experience were invaluable in controlling and co-ordinating its many and varied war-time activities.

As Chairman of the War Office Committee for the study and control of tetanus, he did much to ensure the production of adequate supplies of tetanus antitoxin and, more important, insisted upon its use as a prophylactic. The reduction of the incidence of this disease to less than 0.5 per thousand of wounded in the First World War was a major advance in military surgery and, at a modest

estimate, represented in the British Army a saving of 20,000 lives. Although now superseded, so far as the Armed Forces are concerned, by active immunization with toxoid, serum prophylaxis of tetanus will remain the procedure of choice in civil practice ; the work of the Committee over which Bruce presided emphasized the inestimable value of the procedure.

He also acted as Chairman of the War Office Pathological Committee and of that for the study of trench fever. The work of the Committee on trench fever owed much to his enthusiasm, and its main finding, that this malady, like cosmopolitan typhus, was transmitted by lice and only by lice, indicated very clearly the means of control which finally met with success. Although the mortality from trench fever was low, it was one of the major causes of illness among troops during the First World War, and during 1917, in the British Second Army, accounted for approximately one in five of all admissions to hospital.

The honours conferred upon Bruce were many and were well deserved. The tributes paid to him by learned societies and by universities gave to him much satisfaction, but what he appreciated still more was that in his own Service his work received recognition—special promotion to Lieutenant-Colonel, November, 1900 ; Brevet-Colonel, December, 1903 ; and Surgeon-General, May, 1912. In 1918 he was gazetted Major-General and in that year was also appointed K.C.B. He was the recipient of a Good Service Reward in 1923 and became Colonel Commandant of the Royal Army Medical Corps in 1924.

In addition to the Royal Medal of the Royal Society conferred in 1904, he was the recipient of the Mary Kingsley Medal in 1905 ; the Leeuwenhoek Medal from the Dutch Academy of Science in 1915 ; the Buchanan Medal of the Royal Society in 1922 ; the Manson Medal of the Royal Society of Tropical Medicine and Hygiene in 1923 ; the Albert Medal of the Royal Society of Arts in 1923 ; and had also been awarded the Stewart Prize of the British Medical Association in 1908. He was made a F.R.C.P. London in 1906 and delivered the Croonian Lectures in 1915.

The Universities of Dublin and of Toronto honoured themselves by admitting him to the degree of Doctor of Science *honoris causa*, and those of Glasgow and Liverpool by conferring upon him the LL.D. : he was an Honorary Member of The Royal Society of Edinburgh ; Correspondent, Académie des Sciences, Institut de France ; Foreign Correspondent, Académie de Médecine, Paris ; Membre Honoraire, Société de Biologie and of the Société de Pathologie exotique ; and Corresponding Member of the Royal Philosophical Society of Glasgow.

Bruce was a valuable member of the Council of the Royal Society, served upon many of its Committees, and was also Chairman of the Governing Body of the Lister Institute from 1916 until his death. He gave to all the duties that he was called upon to undertake in connection with these activities the same care, exercised the same sound judgment and showed the same enthusiasm as he devoted to his scientific investigations.

The year 1924 was for him one of fulfilment, for in that year not only was he

appointed Colonel Commandant of the Corps, but also received the signal distinction of being elected President of the Meeting of the British Association which was held in Toronto. It was a fitting and a crowning honour for one whose life had been given to prophylactic medicine, and his Presidential Address was appropriately entitled "The Prevention of Disease."

On first meeting him one felt that he was possibly hard, certainly stern, and perhaps not easy to approach ; but to those who knew him, and who gained his respect, he was the most staunch of friends, ever helpful and, certainly in his later years, he exhibited that admirable trait of giving every encouragement to his junior colleagues. It is true that he did not suffer fools gladly—he did not suffer fools—but that was only an aspect of his common sense. It is equally true that he was an exigent taskmaster, but that also was merely a mirror of his own industry and enthusiasm.

His watchwords were courage, adventure and service, his guide a controlled imagination—a most valuable quality in one who is engaged in research ; common sense marked all that he did and his enthusiasm was ever a spur to others.

A trustee of many talents, he saw to it that he fulfilled his trust by using them to the best of his ability and embellished the gifts bestowed upon him by providence.

His life and his outlook were epitomized in the closing words of his address to the British Association : "We are all children of one Father. The advance of our knowledge of disease is not for the benefit of one country but for all—for the lonely African native deserted by his tribe, dying of sleeping sickness in the jungle, or the Indian or Chinese coolie dying miserably of beri-beri, just as much as for the citizens of our own towns. It is the duty of science to go steadily forward, illuminating the dark places in the hope of happier times."

Like all of us, he had his perplexities, he had to bear disappointment and sorrow, and in the closing months of his life was sorely stricken by a painful malady, but he also had his days of joy and of triumph. Sustained to the end by his courage, and in the knowledge that he had spent himself in the service of others, he died in London on 27th November, 1931.

It was typical of him that, when told of the demise of Lady Bruce, he paid to her, to whom he owed so much, a compliment beautiful in its simplicity and characteristically forthright : "We have had a great life together."

There was a phrase often upon his lips : "On, on and no regrets," a fitting epitaph for one motivated by high ideals and an inspiration to all.

# SIR DAVID BRUCE: AN APPRECIATION OF THE MAN AND HIS WORK

BY

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I SHOULD like to begin by saying how much I appreciate the honour of being asked to give this lecture and also to say how inadequate I feel to my task.

It is one thing to have known a remarkable person and quite another to convey his quality to a later generation. If, when I have done my best, anyone says to me, "But that is not the David Bruce that I knew," the answer is simple. During Bruce's lifetime there were several dozens of him that walked the earth reflected in the minds of those who knew him. Now that he has been dead for twenty-four years this number diminishes, but no doubt as large a collection of phantoms animates his legend.

I am describing Sir David Bruce in the light of the man as I knew him in the last twenty-two years of his life. I am naturally giving an account of him chiefly from my angle, which was that of a much younger worker, but not that of a junior officer serving under him in the R.A.M.C. But I also hope to give some idea of his peculiar quality as a man and a scientist.

Bruce was born in 1855 and he was in the middle fifties when I first met him. He had still ten years of service in front of him.

This lecture makes no claim to be in any sense a complete biography, though it is naturally biographical in character, and I should like to acknowledge my debt to the excellent obituary notice of 1932 in the Proceedings of the Royal Society.

In thinking of Bruce one has always to remember his period. Born during the Crimean War, and reaching Edinburgh University in 1876 at the rather late age of 21, he came under the general influence of the great expansion of science, including medical science, of the last half of the nineteenth century.

Biology in its widest sense made great strides in the years from 1876 to 1886, and Bruce had always a particular interest in natural history; indeed most of his work shows the biological approach. The new outlook in medicine, and particularly the recognition of the causal agents of communicable disease opened up by Pasteur and Koch and many others, were bringing a change in the attitude of mind of the younger men.

Lister was already well on his way to revolutionize surgical procedures, and all this was going on round Bruce in those formative years.

One could hardly have found a man more admirably suited by temperament, by the peculiar type of his intelligence and by his character to this particular period in medical science. There were problems, especially in ætiology and in

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tropical medicine, awaiting just Bruce's type of attack. He had a very direct mind, the biological acumen and the tenacity to make a success of any problem in this field where the frontal attack was applicable. A man is very fortunate when he suits the age into which he is born.

Bruce qualified in medicine in 1881. It did not take him long to discover that he was not cut out for private practice, but the attempt was made at Reigate, where he had the good fortune to meet the woman who became his wife. She was Miss Mary Elizabeth Steele and was the daughter of a distinguished medical practitioner of that town. They were married in 1883 and Bruce then joined the Army Medical Service.

It was when Bruce was stationed in Malta as an Army Medical Officer only a year later that he made his first remarkable contribution to medical knowledge by discovering the infective agent of Malta fever, which was the cause of a great deal of serious sickness among the troops and sailors in the Mediterranean area. He called the organism *Micrococcus melitense*. In 1920 Meyer reorganized the group, which by this time contained also the closely allied type discovered by Bang and found to be the causal agent of the most serious form of contagious abortion in cattle, under the name of *Brucella* with the two species *Br. melitense* and *Br. abortus* and a third less generally accepted *Brucella tularensis*.

During a series of investigations in Malta in 1904, when Bruce was chairman of the Royal Society's Malta Fever Commission, the connection of Malta fever in man with the infection in goats and its dissemination by the use of the milk of these animals was established by Zammit.

After his first spell of work in Malta, Bruce, accompanied by his wife, spent some time in 1889 in Robert Koch's laboratory in Germany.

I am not going to trace Bruce's scientific work in detail as, to begin with, it will be familiar to many of you and it can be read about in the appropriate places. But I do want to draw your attention to Bruce getting into his stride in the middle eighties of last century, applying the then new techniques of the infant science of bacteriology, and using his frontal attack with the greatest success. In a brief sketch like this I propose to select certain aspects of Bruce's work for attention. I want to give you an outline of Bruce's admirable attack on the problem of nagana in 1894-1896 and an account of some of his activities in the First World War, particularly his interest in the occurrence of tetanus among troops in the field and in hospital.

#### NAGANA

The nagana research in Zululand in 1894-1896 is not only an excellent piece of work but is very characteristic of his capacity. He was accompanied on this expedition by his wife. In retrospect, in spite of the considerable hardship involved, Lady Bruce spoke of it as one of the happiest periods of their lives.

In 1918 Sir David gave me a copy of the Nagana Report ceremonially inscribed in red ink. It is a valued possession. It is interesting to note in passing that the author is described on the title page as Surgeon-Major David Bruce,

A.M.S. This rank is now I believe obsolete, and the date of the report is before the reorganization of the Army Medical Service in its modern shape.

Bruce had when he started out in this field of research certain things to go on : (i) Nagana was present in a particular type of country. In Zululand the area chosen for the study was low and humid and lay between two rivers. This, to quote the report, was " 'fly' country, the home of nagana and malaria and uninhabited except by wild animals." (ii) The "fly" was identified as *Glossina morsitans* or the tsetse fly. (iii) It was already known that the disease was characterized by—to quote again—"The constant occurrence in the blood of an infusorial parasite either identical with or very closely resembling *Trypanosoma evansi* found in Surra, a disease of horses in India and Burma." Bruce had already seen this organism in the blood of African cattle in 1894.

Two local theories concerning the disease were current : (i) That held by the white settlers, that the fly caused the disease and might by itself have a poisonous bite. (ii) That held by the African natives that the presence of game in large numbers caused the disease and in some way contaminated the grass and the drinking water with their saliva or excretions. Both these theories have, as we now know, some element of truth in them.

There was another theory that the disease was the product of certain physical conditions obtaining in regions to a certain degree tropical, and that the immediate cause was either malaria or a vegetable poison. Bruce, as you will see, kept this third hypothesis in mind, but as we now know it was far from the mark.

Bruce established himself on a hill above the fly area where he could keep his experimental animals outside the danger zone. He started by finding out what he could about the fly itself. He then obtained a small supply of tsetse, confined them in a gauze-fronted, little cage and fed them for some time on normal susceptible animals, mostly dogs but also horses and donkeys in order to retain the natural conditions of the disease. When he had established that the animals had not become infected, he then showed that the flies themselves even when broken up in saline and injected under the skin of normal dogs were not able to produce the disease. Bruce had a bit of luck here as one of these flies might have been a carrier and at this time he had no source of known clean flies. In his later work, when the pupæ of *G. palpalis* could be obtained in numbers, there was always an abundant source of newly-hatched flies which had never fed.

Having thus cleared the flies as a source of nagana in themselves, he turned his attention to seeing if, and how, they transmitted the hæmatozoon or "virus," as he was still apt to call it.

He allowed flies to feed on heavily infected dogs and then transferred the cages quickly on to normal dogs and found he could transmit the disease. This was known to later workers as direct transference of the disease as distinct from cyclical transmission. Bruce did not at the time of the report think of a cyclical transmission, but found that the direct transmission could occur occasionally, but much more rarely, after an interval of twenty-four hours, and on one occasion after forty-eight hours.

Bruce was in no sense a protozoologist and never became one. His interest in



the Trypanosome was as an agent of disease and he was not touched by the controversies about the nature of the nucleus or the kintonucleus and so on. He was unmoved when he learnt that the useful and simple fixation by drying and the use of the Leishman-Giemsa stains burst the nucleus and gave a pretty but inaccurate picture.

He tried drying the infected blood on a piece of thread and slipping it under the skin of an animal and succeeded on rare occasions in producing an infection ; probably a few trypanosomes were imprisoned alive in a not completely dry clot. He concluded that the blood soon became inert on drying.

At this stage I want to point out that the transmission of malaria by mosquitoes had not yet been discovered, and there is an interesting and rather touching paragraph in which he discusses the result of taking a horse into the fly belt and preventing it from eating or drinking, while observing that many flies settled on it. In discussing this the thorough Bruce does not consider that the means of passage *must* have been the fly because, as he writes : "There may have been other ways of taking the disease, for example, inhalation. The disease called ague or Malarial Fever in man is of all diseases probably the one most nearly related to the fly disease in animals. They are both caused by blood parasites belonging to the Protozoa, and both are found under similar physical conditions. In the case of the much studied and familiar Malarial Fever, none have, up to the present, had the courage to assert that man could be immune by merely taking care what to eat and drink while in a malarial district, or in other words only to eat cooked food and drink boiled water while there. On the contrary it is asserted by the latest authorities that merely breathing the air of malarious districts is sufficient to set up the disease ; in other words, that the parasite can obtain entrance into the system from the air."

The paragraph is too long to quote *in extenso*, but Bruce feels sceptical about the hæmatozoon being able to form a spore in which it can exist as a dry impalpable dust. Indeed he well might.

He settled the main point, however, in another way ; he brought up flies from the fly belt in large numbers and let them bite a horse which was carefully kept on the hill, and successfully infected it. He also found that the blood of the wild game shot in the fly belt would cause infection when injected into his experimental animals.

This is Sir David Bruce at his best—again the energetic frontal attack, the sifting of the evidence and the tenacious testing of his own conclusions. We must remember when we read work of this date that there was no "cloud of witnesses" whose published work could give directives to help in the interpretation of the facts which often stood alone, and the scientist had to make what he could of them and come to some conclusion.

Bruce quotes some curious errors current at the time of writing the report, which he did not question, such as that *T. lewisi* in the rat and the trypanosome of surra were identical. And Lingard had averred that he had caused the disease in a horse by injecting *T. lewisi*. Lingard noted that the incubation period was very long—63 days—but that the infection was very virulent when it developed.

He obviously had not ensured that the horse did not become exposed to a surra infection on its own.

This report laid the foundation of the trypanosome work in Africa, and though there was much more to be done, a proportion of which was carried out under Bruce's direction, the broad outline was clearly contained in this research. The most important filling in of the story was done by Kleine and his co-workers who discovered the cyclical development in the tsetse.

This early work of Bruce's was done in Zululand under great difficulties and in isolation except for the ever-present help of Mary Bruce, who stood up to the rough life; used her skill and ingenuity in constructing all manner of useful things; made stained preparations; did a lot of the searching of fresh blood films for the flicker of the trypanosomes' undulating membrane, and took her full share of the field work even with a rifle.

The Bruces spent several more years in South Africa, and Sir David served with the Army as a surgeon during the Boer War with his wife doing the work of a nursing sister. They were involved in the siege of Ladysmith.

Bruce had been elected a Fellow of the Royal Society in 1899 while absent in Africa, and from the period of his return in 1901 he was recognized as a worker of great importance.

I have dwelt particularly on the nagana research as Bruce did this work by himself with Lady Bruce, but not as the leader of an able team of younger scientists. From now onwards he began to be more and more involved with Royal Commissions and to find his talents employed in inaugurating and co-ordinating the researches of a group of workers. In fact we have here one of the early examples of the use of a team to attack scientific problems or to meet a medical crisis.

It comes with a certain shock of surprise to the modern scientific worker that this method is little more than fifty years old.

Bruce was seconded by the War Office early in 1903 to supervise the work of the Royal Society's Commission sent out to deal with the very serious outbreak of sleeping sickness in Uganda. His experience with nagana quickly showed him the main lines on which to approach the problem, and in a few months the disease was found to be another trypanosome infection with the tsetse fly *Glossina palpalis* as the insect vector. This work brought Bruce the award of the Royal Medal of the Royal Society for the year 1904. After this, honours of various kinds accumulated, all of which he honestly enjoyed without any pretence. His later trypanosome work at Mpumu in Uganda and in Nyasaland was less personal, and he had very able collaborators, such as Captains Bateman and Hamerton of the R.A.M.C., to mention only two. Many other workers made valuable discoveries and the body of knowledge is now a formidable literature, but the problem of the control of trypanosomiasis in Africa is not completely solved even now.

At this point I should like to say something about Lady Bruce. No good account of Sir David can be given without referring to his marriage. It was a most satisfactory partnership and achieved a completeness and a beauty that was

an interesting comment upon the harsher aspect of Bruce as seen in the eyes of some of his contemporaries.

Lady Bruce was a woman of great character and great courage. She was generous-hearted and gifted with both wit and humour. She was well educated in the truly civilized way of a certain type of Englishwoman in the latter half of the nineteenth century. Her gifts were many ; she could draw and sketch well and was musical. Lady Bruce made any shack or hut into a place fit to live in and endowed it with a touch of beauty, and most characteristically she was a gardener. She was a hardy traveller and a good shot. The African women around Mpumu used to tell me how she would cycle down to the lake with a rifle over her shoulder and that she could shoot a hippo. In fact, she was, they said, a "Kitalo," which means a wonder.

Lady Bruce was careless about dress, but it did not matter. When I went to visit her in 1911 before going myself to work on Mpumu after the Commission had left, she very kindly gave me all sorts of good and useful advice, nearly all of which I followed to my great advantage, except in the matter of millinery.

Incidentally, I found a neglected garden on Mpumu which had been Lady Bruce's and which was not too difficult to bring back into shape. It afforded me much pleasure.

Mary Bruce had no pretensions to good looks as such, but her vivid personality shone through and she was a fascinating woman. Her influence on Sir David was very great and, while she was never in any true sense a scientist, she was a continual inspiration to him and helped in the work of detail, making excellent drawings and designing and carrying out useful things, such as the curtains round the fly corner in the Mpumu laboratory, to mention only one thing that occurs to me.

Lady Bruce did, I think, canalize Sir David's activities. She certainly curbed his intransigence and his impatience. I well remember having tea with her one day in about 1917 or 1918 while Sir David was Commandant of the College. He blew in with obvious storm clouds upon his brow and, on being asked how the meeting at which he had been had gone, said, "There is a good deal of opposition," upon which Lady Bruce remarked that if he would avoid telling people at the outset what incredible fools he thought they were, he might find things work more smoothly. She was the most loyal of wives and they were practically never parted. In the end, his last few years were greatly saddened by her prolonged illness. Sir David often referred in conversation with me to the extent and the value of her help in every aspect of his work and life.

Bruce towards the period of his later trypanosome work was beginning to pay the penalty of his success, and on returning to England from Nyasaland in 1914 he was made Commandant of the R.A.M. College and, much to his regret, did not go on active service in the 1914-18 war. In 1903 he had become a member of the governing body of the Lister Institute as the representative of the Royal Society, and at the death of Sir Henry Roscoe in 1915 he became chairman of the Institute.

It was at this time from 1914 onwards that I saw a lot of Sir David Bruce as

he took a keen interest in the work going on at the Institute. I had begun to work on the spore-bearing anaerobes present in war wounds and so came into contact with him.

During the year 1915, a disastrous epidemic of typhus broke out in Serbia and there was a general anxiety about the possibility of the disease spreading among the troops and among the populations of other countries. The louse had only just begun to be incriminated as the vector. The infective organism was not definitely known although several bacterial types had been isolated, none of which proved in the long run to have anything to do with typhus.

In 1914 the late Dr. Penfold, who was then a member of the Lister staff, had isolated a hæmolytic coccus from the blood and urine of typhus patients in Belfast. The possibility of this organism being useful as a vaccinating agent in protection against the disease attracted Sir David, and I was asked to carry out the project.

It was not a very good idea as the connection of the organism as a causal agent with the disease was by no means established. Sir David, however, was not impressed by the two main objections ; the one which I have just stated and the further one that vaccination might not afford protection. . . . He had so often been successful with the frontal attack . . . it might be a long shot but he felt it must be tried. So I vaccinated the monkeys in 1916 and I took them to Ireland, where the disease was still to be found in the far west. In the event the vaccination gave no protection and both the treated and control animals took the disease, giving the characteristic febrile reaction and one death. Dr. Penfold's hæmolytic coccus was again recovered from the blood of two patients.

Now we know that typhus was not to yield to this kind of approach.

About this time the War Office set up a Committee for the investigation of tetanus, with Sir David Bruce as its chairman. I am only going to touch rather lightly on the tetanus research, as, while I worked at one aspect of it for some time, Professor Tulloch carried out a much more detailed and extensive piece of work, and I am told he is giving an account of the investigation in the *R.A.M.C. JOURNAL*. It must be remembered that these were the days before there was any word of an active immunization against tetanus. The injection of antitoxin into all wounded soldiers at the first dressing station had cut down the incidence of this terrible infection to very low numbers. But Bruce's interest was aroused by the occasional late reappearance of tetanus cases especially as a result of further surgical intervention among wounded troops who had received antitoxin at the field dressing station. So at his suggestion I undertook the examination of a series of cases classed as "septic wounds" but showing no symptoms of tetanus.

The cultures grown from 252 cases could be divided into three classes : 32.9 per cent. which showed no anaerobes, 41.6 per cent. which showed growth of anaerobes but none with round endspores, and 25.5 per cent. which showed the growth of organisms with round endspores along with other anaerobes. Amongst this third group 9 or 15 per cent. of the cultures were toxic, producing a tetanus

reaction when injected into mice but not in controls which had been given tetanus antitoxin.

Bruce took a great interest in the work and I remember him coming frequently to see me at the Lister. Sir David in his full General's uniform was an impressive figure, and I used to have a slight feeling as of one about to receive cavalry when he appeared with a certain amount of the accompanying rattle of Sam Browne belt, etc.

I found this particular piece of work rather uncongenial, and I think he appreciated this as he used often to leave me with the rather cryptic slogan, "On, on and no regrets." Exactly what this referred to, I never discovered. There are incidentally some picturesque sayings of Bruce's, one of which appeared in one of his later trypanosome papers referring to some difficulties in African field work : "The sun is hot and the country is difficult." This used to be quoted by later and younger workers on Mpumu in Uganda on hot days with heartfelt agreement.

The final big tetanus report was Bruce's last piece of work and, as I have already said, I am leaving this in the able hands of Professor Tulloch.

Bruce retired in 1919 but served for some years on many advisory committees. He was president of the British Association in 1924 when the meeting was held in Toronto, and his presidential address bore the title "The Prevention of Disease." He started out with an apology, which sounds curiously old-fashioned in these days, for addressing the Association on this matter which might not seem to them to be a very pleasant choice. He excused himself on the grounds that, after all, it was humane and important as advancing the happiness and efficiency of man. This is an interesting address ranging over all the aspects of prevention and over all the known types of disease which were then amenable to prevention. Infections of all kinds from those caused by bacteria and protozoa to the less well understood rickettsial and virus diseases were dealt with ; dietetic deficiencies, then rather a new branch of medical knowledge, and glandular imbalance of various types were all considered.

The first meeting of the Association held in Canada was in 1884, which coincided with Bruce's own start in scientific investigation. He used this span of forty years to show the advances made, and in the last three paragraphs of the address he stated what amounted to his scientific creed.

I quote a few characteristic sentences :

"Before that time (1884) we were still in the gloom and shadow of the dark ages. Now we have come out into the light. Man has come into his heritage and seems now to possess some particle of the universal creative force in virtue of which he can wrest from Nature the secrets so jealously guarded by her and bend them to his own desire. . . .

"Mankind is still groaning and travailing under a grievous burden and weight of pain, sickness and disease . . ." and he finished with the words : "It is the duty of science to go steadily forward, illuminating the dark places in hope of happier times."

Bruce kept his connection with the Lister Institute until his death. Retirement

ment gave him little pleasure as he was without the type of hobby that could be pursued with advancing age and he had no vital concern with the arts. He was a good shot and had been a good tennis player. He resented it when in the mid-twenties he had to spend the winters in Madeira because of a tendency to chronic bronchitis.

As a person Sir David Bruce was picturesque, able and forthright ; he had what might be called a practical type of imagination, but was not very subtle. He held the opinion indeed that subtlety belonged to the group of intellectuals that (without using that now almost detrimental term) he considered suspect and thought of as those "long-haired chaps." He had, however, a real enthusiasm—indeed a passion—for science and never doubted that it held the key to progress.

I only actually met Sir David when we were both in London, and I never saw him other than immaculately dressed in morning coat or well-cut lounge suit or perfect uniform.

Bruce belonged to his day and he made very good use of it. He earned the well-deserved distinction of leaving a mark on the Medical Science of his period.

[Dr. Robertson illustrated her lecture with lantern slides selected from Sir David Bruce's own collection.

We are glad to note that the Lister Institute has decided to give Sir David Bruce's large collection of lantern slides to the Royal Army Medical College as being the most suitable body to have the care of them.—Ed.]

## THE CENTENARY OF BRITISH MILITARY PATHOLOGY\*

BY

**MAJOR-GENERAL A. SACHS, C.B.E., Q.H.P., M.D., M.Sc., M.R.C.P.**  
*Deputy Director of Medical Services, Eastern Command*

I HAVE used the term "pathology" in the widest sense to include all branches. We have listened for the past ten days to so many scientific discussions that I feel it would be appropriate to have a historical interlude.

Modern science has advanced so rapidly in recent years that certain branches of pathology have just grown up on insecure foundations. Sooner or later a time must come when pathologists will need to call a halt and take stock of their accomplishments, consider what was worth doing and plan for the future. So much good in the past has been forgotten and at times I am surprised about old discoveries which are being constantly rediscovered. I am convinced that when designing experiments, we do not pay sufficient attention to the accomplishments of past workers. I speak feelingly, because I have made this mistake in the past, and many valuable hours would not have been lost in redundant work, a loss of time which could have been prevented had I only read my subject widely enough and taken the trouble to design my experiments adequately.

On 27th April next year it will be a hundred years since pathologists were first appointed as such to the Medical Department of the British Army. I therefore feel that the British Military Pathology Service has now reached that stage of maturity in its existence when Army pathologists should stand back and take stock of what has been accomplished, consider what was worth doing, and plan for the future. Military pathology has indeed been built on firm foundations. Can any instructions be clearer or more definite than those given by the then Secretary for War, Lord Panmure, to Dr. Lyons and his two assistant pathologists, Dr. Aitken and Dr. Doyle, on their new appointment within the Medical Department of the Army with reference to the Pathological Researches about to be carried out in the hospitals attached to the Army in the East? I feel we should have much to gain by paying close attention to some of the injunctions. How many of us fail to remember Instruction No. 4.† "As morbid anatomy is of little value unless studied in connection with the history of the disease, you and your assistants will require to visit the Hospital wards in order to become acquainted with the symptoms and characters of the diseases during their progress; but you will not interfere with the treatment of the patients. In making notes of the cases, the name of the patient, and the number of his regiment, should always be stated, as by this means the nature of his duties, and the

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\* A lecture delivered at the Armed Forces Institute of Pathology, Washington, D.C., on 15th September, 1954.

† The text of the Instructions is reproduced at the end of this paper.

place where he was first attacked by disease can be more easily ascertained." Nowadays, there is a tendency for the young pathologist to seek a cloistered life in the laboratory, rarely if ever emerging to visit the wards. I should also like to draw your attention to Instruction No. 6. Even at that early date the importance of a microscopical examination is stressed in an era where little was known about the staining of tissues.

The findings of these pioneer Army pathologists were published in the form of a blue book of 120 pages, "The Report on the Pathology of Diseases of the Army in the East," signed jointly by Dr. R. D. Lyons and Dr. W. Aitken, and presented to Parliament in 1857 by order of the Secretary for War.

This report is a most interesting one and morbid anatomical findings are clearly described. What interested me particularly was a differential diagnosis of the different types of gangrene. A clear description is discernible of the condition we know as gas gangrene, though often called hospital gangrene. The differences between the typhoid and typhus fevers are stressed. From a perusal of the description of fatal dysentery cases, one can select those which are obviously of amœbic origin, although the causative origin was not then known.

There is also a catalogue of the specimens collected and sent to the museum of the then important Medical Centre at Fort Pitt, Chatham, which was the Headquarters and the Depot of the Army Medical Staff Corps. Some of these specimens still remain in excellent condition in the museum of the Royal Army Medical College at Millbank. There is an early reference to a museum at Fort Pitt in 1838, some of the specimens in which were said to surpass those in the British Museum.

The next important landmark in the history of pathology was the establishment of the Practical Army Medical School at Fort Pitt, Chatham, in October, 1860. This moved to Netley three years later. The importance of pathology was recognized by the War Office. Dr. W. Aitken was appointed the first Professor of Pathology—there were not many professors of pathology in Britain at that time. Professor Dible tells me the first was at Edinburgh in 1831. This appointment was certainly an apt tribute to the excellence of Dr. Aitken's work in the Crimea.

It is interesting to realize what great difficulties had to be overcome before the Army Medical School was established. Here, again, the Army Medical Service owes much to Florence Nightingale. The following extract, taken from her biography by Mrs. Woodham Smith, is illuminating and throws some interesting light on the gestation period of the college.

"Sidney Herbert had just had a demonstration of War Office power in the matter of the Army Medical School. Miss Nightingale had set out the necessity for an Army Medical School in *Notes on Matters affecting the Health, Efficiency and Hospital Administration of the British Army*. Young men were formerly sent to attend sick and wounded soldiers who *perhaps* had never dressed a serious wound . . . who certainly had never been instructed in the most ordinary sanitary knowledge, although one of their most important functions was



hereafter to be the prevention of diseases in climates and under circumstances where *prevention* is everything." The school was designed to provide training in military hygiene and military surgery. Miss Nightingale drew up the regulations in consultation with Sir James Clark, and the nomination of its professors was left entirely in her hands. The third of the four sub-Commissions which Sidney Herbert extracted from Lord Panmure was concerned solely with it.

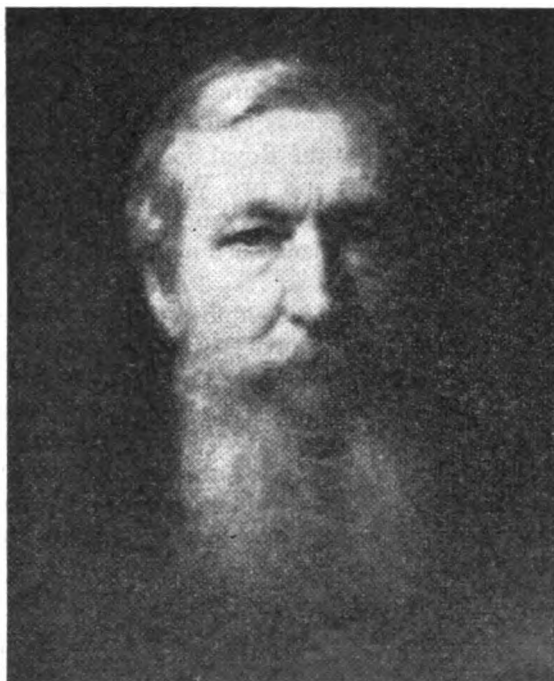
The nominations were made in 1857. Dr. Parkes, the great military sanitarian, was to be Professor of Hygiene and Dr. William Aitken, later Sir William Aitken, to be in charge. Panmure could not be got to the point of making the appointments; he would not actually appoint anyone "even if the Angel Gabriel had offered himself, St. Michael and all angels to fill the different chairs," wrote Sidney Herbert. Panmure went out of office and General Peel succeeded him, but still nothing was done. Then General Peel was succeeded by Sidney Herbert, who wrote that something should be done about the Army Medical School "at last." He converted nominations into appointments, but delay continued; the officials in the War Office were not yet defeated. Premises were selected at Fort Pitt, Chatham, yet work on them did not begin; the professors were appointed, but their salaries were not paid; requisitions were sent in for instruments and equipment, but they were not filled. Month added itself to month, it was a year, it was two years, it was nearly three years since the original authority for the establishment of the school had been given, and still nothing had been accomplished. In 1860 Sidney Herbert insisted on fixing a date for the opening of the school. Three letters sent by Miss Nightingale to Douglas Galton, in August of that year, relate what occurred. The first from Dr. Aitken, marked "Wail no. 1," states: "No work even begun." The second, also from Dr. Aitken, marked "Wail no. 2," states: "No money for instruments." The third from Miss Nightingale herself, dated 3rd September, 1860, marked "Wail no. 3," relates the "disaster of the opening day": "On Saturday I had a letter from the Professors of the Medical School quite desperate . . . the authority for the instruments and the money had not yet come. Ten of the students arrived. They stared at the bare walls and in the absence of all arrangements for their work concluded the school was a hoax."

Such were the foundations of the Army Medical College. The first stage in building up the Army Pathology Service may be considered to have coincided with the period 1860-1892, when William Aitken was the first Professor of Pathology.

This period also happens to be that of the development of the Army Medical Service; and the realization of the importance of and necessity for conserving manpower by the prevention of disease and the treatment and cure of the sick and wounded acted as the stimulus for research work which was to lead to the subsequent discoveries made in bacteriology, protozoology and immunology.

SIR WILLIAM AITKEN had a long and distinguished career. His appointment as first Professor of Pathology in October, 1860, was the outcome of the experience of the Crimean War, and one for which his early training and matured experience in the military hospitals of the East particularly fitted him and which

his subsequent career at Netley justified. He held the Chair of Pathology for thirty-two years until his death in April, 1892. It is said that as a teacher he was eminently successful in his method of imparting knowledge ; his reasoning was scientific and practical, his demonstrations lucid and convincing. William Aitken was elected a Fellow of the Royal Society in 1873, and knighted in the Queen's Jubilee Year, 1887. He made numerous contributions to pathology and medicine, and at that time was best known for his great work on the *Science and Practice of Medicine*, published in 1857, which reached seven editions, was



SIR WILLIAM AITKEN .

for a long time the favourite textbook of students, and in its day the work most consulted by general practitioners throughout the kingdom and in every colony where English is the language of the people.

It is recorded that no pathologist of his time could conduct post-mortem examinations with more knowledge and dexterity. Netley men all over the world, particularly those who passed through the Army Medical School in the days of Sir William Aitken, well remembered his teaching.

It was thus natural that the interest of Army Medical Officers should be stimulated into research work by the father of military pathology, who made his influence felt on the rising generation of young Army pathologists who were to contribute so much to unravelling the mysteries of tropical diseases. It would indeed be difficult to over-estimate the influence of the Army Medical School

on the course of tropical pathology and medicine in the world at large through the work of Army pathologists like Bruce, Ross, Leishman, Semple, Cummins, Lewis, Boyd, and many others. The application of their work to the health of the soldier in peace and war must be an inspiration to all Army pathologists, irrespective of their nationality. The rewards were theirs in life, their work remains.

It is of interest to reflect on the remarkable achievements of the early pioneers of military pathology, when considering the magnitude of the research work carried out under difficult conditions with the limited laboratory facilities and equipment then available, and particularly the type of microscopes in use.

Effort in research tended to be somewhat more individual than it is today, though urgent problems such as those presented by the ravages of typhoid fever, Malta fever, and sleeping sickness called for a combined effort resulting in the formation of Commissions of the Royal Society to attack the problem and solve it. The South African War and two World Wars have profoundly influenced the advance of military pathology in a way no other circumstances could. New problems and diseases demanded new techniques and new methods for diagnosis.

After the death of Sir William Aitken, Surgeon (later Major-General Sir) David Bruce, who had been appointed Assistant Professor of Pathology in 1889, temporarily officiated as professor until Dr. (afterwards Sir) Almroth E. Wright, at the early age of thirty-one, was appointed second Professor of Pathology on 1st September, 1892.

The second stage, continuing until the outbreak of war in 1914, and perhaps the most glorious era in the history of military pathology, was now to follow—discovery succeeded discovery. Some of the more important of these can well be mentioned.

### *Anti-typhoid Vaccine*

Early in 1893 Haffkine visited Netley and demonstrated his method of inoculation against cholera by injection of live cultures of the causative vibrio. It seems possible that this suggested to Wright and his co-workers the practical possibilities of anti-typhoid vaccination. After Bruce's departure for South Africa in 1894, Wright was joined by Semple, and in 1897 by Leishman on his return from India, to form the team which was largely responsible for the introduction of anti-typhoid vaccine into the Army.

In 1898 a trial of the vaccine was first instituted on a large scale in volunteers in the British Army in India. It is recorded that these volunteers had to be bachelors! In the following year, 30,000 men were inoculated against typhoid fever on board ship, the majority being *en route* for South Africa. I have noted from a photograph upstairs\* that the first typhoid fever vaccine injection in the U.S. Army was given in this building in 1909! I don't know whether these volunteers were also bachelors.

Subsequent to the South African War, inoculation against typhoid was held

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\* A laboratory in the building of the Armed Forces Institute of Pathology.

in abeyance until the results of further experimental work were ascertained. The fact that further experiment and experience did lead to some improvement in the vaccine originally devised by Wright and Semple does not detract from their pioneer work. This further experimental work was carried out in the Pathology Department of the Royal Army Medical College in London by Leishman and others—Leishman had succeeded Wright as Professor of Pathology in 1903. This work was eventually successful in producing what was then accepted as statistical proof of the protective effect of the vaccine. With this, it was possible in 1909 to convince the Army authorities, both medical and military, that typhoid inoculation was a safe and successful procedure and permission was accordingly regranted for its general employment, but always on a voluntary basis.

The continuous and original research of many officers of the R.A.M.C. in India and elsewhere at this time contributed greatly to the advance in laboratory methods of diagnosis of enteric group infections.

### *Brucellosis*

Malta fever was a serious drain on the manpower of the Army and Navy in Malta over a period of years. Military interest in Malta fever had begun many years earlier, an admirable clinical account, though one which makes no contribution to ætiology and pathology, by Assistant Surgeon J. A. Marston having been published in the Report of the Army Medical Department for 1863.

This interest is not to be wondered at when it is realized that the average duration of an attack is four months. Little advance had been made in the control of the disease since the discovery of the organism by Bruce in 1887, its method of entry into the body having defeated all attempts at solution. Wright and Semple of the Army Medical School by means of the agglutination test did much to demonstrate that the distribution of the disease extended widely beyond the confines of Malta and the Mediterranean, and to differentiate this infection from enteric, malaria and other specific fevers. But as late as 1904 no one had found the parasite in "external nature." There were various theories as to its mode of spread and at one time drinking water was blamed.

In 1904 a commission was appointed with Bruce as chairman, and in the following year the problem was solved by the discovery that the goat was a highly susceptible animal. Prior to this the goat had been presumed immune and in no way involved in the spread of the disease, as it had not been found possible to infect it with artificial cultures. Investigation showed that half the goats in Malta were infected and 5 per cent. of them had infected milk. This discovery enabled preventive measures to be taken.

### *Leishmaniasis*

The finding of a new protozoon in the spleen of a soldier suffering from "Dum-dum fever" by Major W. B. Leishman, R.A.M.C., was one of the most interesting and important discoveries of the early twentieth century. One must

pay tribute to the keen observation which enabled Leishman to detect these minute bodies in the splenic pulp. There can be little doubt, too, that an excellent staining technique contributed to his success, because at this time he was working on the Romanowsky stains, and was to publish his note on his method of staining in the following year (1901). Leishman thought at first that these bodies might be fragmented nuclei of trypanosomes and did not place his observations on record till some three years later. Some time after, in the Army Medical School, Wright found Leishman-Donovan bodies in the lesions of "tropical ulcer," establishing the ætiology of this condition. It was not, however, until some years later that successful transmission of kala-azar by the bite of the sandfly was effected by the notable work of members of the Indian Medical Service. The sandfly had been incriminated on epidemiological grounds for many years as the transmitter of *Leishmania* infections, but it was only during the recent war that this was proved by workers in India, who successfully infected volunteers by sandflies which had been kept alive by a newly discovered method of feeding.

### *Sleeping Sickness*

The following announcement appeared in the *London Gazette* of 18th December, 1903: "The undermentioned Lieut.-Colonel to be Brevet Colonel—David Bruce, F.R.S., M.B., R.A.M.C., in recognition of his services in investigating the cause of 'Sleeping Sickness' in Uganda, as well as in consideration of the distinction already attained by him in researches connected with Malta fever and tsetse-fly disease." This was the first brevet promotion to be awarded for distinction in original research. Our knowledge of medical trypanosomiasis dates back to the discovery of a trypanosome in the blood of rats by Surgeon-Major T. Lewis, F.R.S.-elect, in the 1870's. In 1903 Bruce joined the Commission on Sleeping Sickness already established in Entebbe, Uganda, and, with his work on tsetse-fly disease in cattle fresh in his mind, was quick to appreciate the significance of Castellani's discovery of a trypanosome in the cerebrospinal fluid of cases of sleeping sickness, seized upon it and pursued it in collaboration with Castellani, to whom Bruce was the first to give credit for the discovery of the parasite.

Other members of the R.A.M.C. working under Bruce at this time on the Sleeping Sickness Commission were Captains Hamerton and Bateman. We must also pay tribute to the memory of Lieutenant Forbes Tulloch, R.A.M.C., another member of the Commission, who was infected with trypanosomiasis in Uganda and died of a virulent form of sleeping sickness in London in June, 1906. Published works of the Commission included studies on the development of *T. gambiense* in *Glossina palpalis*, on trypanosomes found in the blood of wild animals, and on trypanosomes as a cause of disease in domestic animals. They found time, moreover, to study a disease of the native known as "mukinyo," which proved to be undulant fever, and a disease of cattle known as "amakabe," which was in fact the same as East Coast fever and was due to the presence of a piroplasma in the blood.

I have given you a brief résumé of some of the accomplishments of the Army Pathology Service before the first war, which I think you will agree are noteworthy achievements that have influenced the course of pathology and medicine. By the outbreak of the First World War we had advanced a long way from that date in 1855 when pathologists were first appointed to the British Army. What kind of men were these pioneers and early stalwarts of military pathology, who had made these advances ?

As early as July, 1862, JOHN DAVY, M.D., F.R.S., Inspector-General of Army Hospitals, published a book entitled *On Some of the More Important*



SURGEON-MAJOR TIMOTHY RICHARDS LEWIS

*Diseases of the Army, with Contributions to Pathology.* In this interesting book are included chapters on the pathology of cholera, fevers, peritonitis, cellular inflammation and coagulation of the blood. Even at that early date the microscopic appearances of the blood corpuscles in yellow fever are discussed.

SURGEON-MAJOR TIMOTHY RICHARDS LEWIS was born at Crinow, Narberth, Pembrokeshire, on 31st October, 1841. After studying at first in London, he went to Aberdeen, where he proceeded to the M.B. and C.M. degrees of that University, graduating with honours in 1867. He joined the Army Medical Department in February, 1868, at the age of twenty-seven and passed first in order of merit into the Army Medical School at Netley, where he was later to have a close association with Sir William Aitken.

Lewis was sent to India in January, 1869, for special duty with the Sanitary Commissioner of the Government of India, and from that time until January, 1880, he was entirely occupied in investigating cholera and kindred inquiries. He published numerous papers dealing with leprosy in India, oriental sore, micro-organisms found in the blood of man and animals, a helminth (*Filaria sanguinis hominis*) in the blood. This was the first recorded instance of a nematode hæmatozoon having been found in man. When investigating flagellated organisms in the blood of animals he discovered in the blood of healthy rats a trypanosome which now bears his name, *Trypanosoma lewisi*. From his published description and drawings illustrating the macroscopic and microscopic pathological appearances of cutaneous Leishmaniasis (Delhi boil), I have little doubt that had Leishman's stain been then available to him, he might have discovered the causative protozoon many years before Leishman and Donovan. In 1883 he was appointed Assistant Professor of Pathology at Netley. On reaching Netley he found that his old friend and teacher, Professor Aitken, was seriously ill with nephritis, and at once took upon himself the whole of the duties of the Professor for that session, preparing the pathology lectures required for the surgeons on probation, in addition to conducting his own work in the "microscopical class."

Shortly before his death the value of his many years of patient and laborious work was recognized by the Council of the Royal Society, who recommended him for election as one of the Fellows for that year, and had he but lived a few weeks more, Lewis would have actually received this, the Blue Ribbon of Science. He died at the early age of forty-five on 7th May, 1886.

Lewis is described as being one of those men "who go on and on working and full of work and vigour for the Truth's sake"; and he imbued the minds of those he taught with this same keen love of work.

DR. (LATER SIR) ALMROTH E. WRIGHT was born on 10th August, 1861, in the Yorkshire village, Middleton Tyas. At the age of seventeen he entered Trinity College, Dublin, to study Modern Literature—he took his B.A. with first-class honours in 1882. While still reading for his Arts degree he enrolled in the Medical School, and a year after graduating in literature (1883) qualified in Medicine and Surgery.

In 1892, at the age of thirty-one, Dr. Almroth Wright succeeded Sir William Aitken to become the second Professor of Pathology at the Army Medical School at Netley, and there he came into contact with the men, "Wright's men" they have been called, who were later to become outstanding figures in the medical world. He held this appointment from 1892 until his resignation in 1902 to become pathologist to St. Mary's Hospital.

Prior to his appointment at Netley, Sir Almroth had worked in the Medical Research Laboratories of the Royal College of Physicians and had been Demonstrator of Pathology in the University of Cambridge as well as Professor of Physiology from 1889 to 1892 at the University of Sydney.

As mentioned previously, Haffkine visited the Army Medical School in 1893 to demonstrate his method of inoculation against cholera by the injection of

live cultures of the causative vibrio. The method of preparing the vaccine was later demonstrated to his class by Sir Almroth.

It is probable that this visit played an important part in suggesting to Wright and his co-workers the practical possibilities of antityphoid immunization, as it was at this time that he commenced his intensive work which led to the discovery of the all-important fact that killed typhoid bacteria are active immunizing agents.

The scale of his activities was wide and varied, comprising studies in typhoid, anthrax, tuberculosis, pneumonia, plague, cholera, and in microscopy, hæmorrhage and other subjects. His *Technique of the Teat and Capillary Glass Tube* is known to all laboratory workers, and there can be few medical officers who are not familiar with a Wright's capsule.

Almroth Wright was one of the great pioneers. His name will be linked with those of Pasteur, Koch, Ehrlich, and his own pupil, Fleming.

Wright's work which originated at the Army Medical School, Netley, has been of paramount importance to the Services. But he did more for the Army. Who can doubt that the impact of his personality on the young men embarking on a service career did much to determine the course of many of them in scientific medicine?

MAJOR-GENERAL SIR DAVID BRUCE was born in Australia on 29th May, 1855, just over a month after the first appointment of pathologists to the Army Medical Department. He came to Scotland as a child, and after leaving school worked in a warehouse before entering Edinburgh University, where he graduated M.B., C.M., in 1881. On 4th August, 1883, already a married man, he was appointed surgeon, A.M.S.

In 1884 he was posted in Malta, where his work on Malta fever led to his recognition of an organism named by him *Micrococcus* (now, in his honour, *Brucella*) *melitensis* as the causal agent [*Practitioner* (1887), 39, 161]. He also in 1884 carried out an inquiry into an outbreak of cholera, his report on which drew the favourable notice of the Government. He produced other papers on Malta fever, a clinical account being published in the *British Medical Journal* (1889), 1, 1101.

From 1889 to 1894 he was Assistant Professor of Pathology at Netley, under Aitken and Wright, where he continued his work on Malta fever and, after studying under Koch in Berlin, introduced in the Army Medical School the first course in systematic bacteriology to be given in an English Medical School. In 1894 he went to South Africa for seven years of science and soldiering.

He was seconded in 1895 for an expedition to Zululand to investigate Nagana, tsetse-fly disease then being thought to be a different condition. He demonstrated their identity, proved the causal organism was a trypanosome and its vector a fly of the genus *Glossina*. This was the first occasion on which insect transmission of the pathogenic protozoon had been proved.

He then reverted to duty and took part in the defence of Ladysmith, being promoted to Lieutenant-Colonel for his work there, and after its relief on 28th February, 1900, was made a member of a commission to investigate the



relationship between dysentery and enteric. The commission sat from 1900 to 1901, its report being presented to Parliament in 1902.

After his return to England in 1901, most of Bruce's service was spent in seconded employment. In 1903 he went to Uganda as a member of the Sleeping Sickness Commission, where with Aldo Castellani he demonstrated the pathogenicity of *Trypanosoma gambiense*, its transmission by *G. palpalis*, and the importance of game as a reservoir.

From 1904 to 1906 he was chairman of a Royal Society Commission inquiring into Malta fever; this commission, under Bruce's leadership, completed his work of twenty years before by showing the infectivity of goats' milk. Following Bruce's original discovery of the *Micrococcus melitensis*, Wright at Netley had developed a serum agglutination reaction for it which had led to the diagnosis of "Mediterranean fever" being made official in the Navy in 1897.

In 1908 he became chairman of the Sleeping Sickness Commission and in that capacity worked in Uganda from 1908 to 1910, and in Nyasaland from 1911 to 1914, investigating the connection between the parasitic vectors and diseases affecting game animals, stock and man.

Less well known is his work during the First World War, when as Commandant of the R.A.M. College (1914-1919) he served on the War Office Pathological Committee and on the Committee for the study of Tetanus and Trench Fever, and in the latter capacity was mainly responsible for the demonstration, by statistical methods, of the efficacy of prophylactic injections of antitetanic serum for the prevention of tetanus.

General Bruce retired in May, 1919, and died on 27th November, 1931.

His work on Malta fever and on trypanosomiasis needs no comment, though it must be given to few men to prove a causative agent of disease and demonstrate its complete cycle twenty well-filled years later. Bruce's work was his wife's also: she worked in his laboratory in every job he did, with the sole exception that while he fought in South Africa she nursed, but none of his scientific investigations was undertaken without her assistance.

I mention here, not in connection with Bruce's work but only as a means of bringing the fact to your notice, that Lady Bruce's first cousin, General Sir Walter Bedford, is credited with having designed the R.A.M.C. badge.

Bruce was a very human man, as can be gleaned from the following entry in his record of service: "Reported for using ungentlemanly language to the Railway Officials at Portsmouth Harbour, His Royal Highness the Field-Marshal Commander-in-Chief as a mark of his displeasure curtailed his leave to two months (he had been granted four)."

His imposing and commanding figure, his somewhat brusque and incisive manner, and his brilliant record will long be remembered. The work of Bruce was of world-wide interest and of lasting value in bacteriological research.

COLONEL SIR DAVID SEMPLE was born on 6th April, 1856; he qualified M.A., M.Ch., from Queen's College, Belfast, in 1881, and was commissioned Surgeon, Army Medical Staff, on 3rd February, 1883. He took the Cambridge D.P.H. in 1892 and in 1893 spent his leave in Cambridge studying bacteriology

under Sims Woodhead, the virtual founder of the Pathological Society of Great Britain and Ireland. In 1894 he was appointed Assistant Professor of Pathology at Netley under Almroth Wright in succession to David Bruce.

Here he continued the work Wright and Bruce had begun on anti-typhoid vaccines and on Malta fever, though with neither is his name strongly associated.

In 1899, on relinquishing his appointment at Netley and before leaving for India, Semple spent his leave in Paris studying anti-rabic treatment under Pasteur, and from this time his life's work really begins.

In 1900 he founded the Pasteur Institute at Kasauli, the first of its kind in the British Empire, which he directed until his retirement from the R.A.M.C., after twenty-two years' service, in 1905.

He then accepted service under the Government of India and at once, in 1905, founded and became first Director of the Central Research Institute, also in Kasauli. This was a logical continuation of his work at the Pasteur Institute, where in addition to production and trial of a carbolized dead vaccine for therapeutic use in cases of rabies, he had worked on vaccines against typhoid, diphtheria and tetanus, as well as on production of an anti-venene against cobra venom. The issue of this started in 1903 and was later augmented to protect against the bite of Russell's viper.

His first task (1905-1907) as Director of the Central Research Institute was the conduct of an inquiry into typhoid fever in India, with especial reference to the means by which the disease was contracted. His work pointed the importance of spread by convalescents and carriers and led to the establishment of convalescent camps for typhoid cases, to the implication of coolies and food-handlers as prime sources of infection, and to the introduction of serum-agglutination tests for their recognition and elimination. A great reduction in the disease in the Army soon resulted from the preventive measures adopted.

From 1909 to 1912 he was a member of the Central Committee for the Study of Malaria in India, and from 1911 to 1913 a member of the Advisory Committee on Medical Research in India.

In 1913, under Indian Government regulations, he retired on grounds of age, resigning his Directorship at Kasauli, and was immediately appointed, at the age of fifty-seven, Director-General of the Egyptian Public Health Department, an appointment which he held until 1918, doubling it between 1915 and 1918 with work as a Colonel A.M.S. for the British Army in Egypt, when he finally retired from public life.

Semple has no eponymous memorial, either written or builded. His greatest work was produced by the combination in him of a trained, disciplined, scientific outlook and an inspiring gift for leadership and administration of his contributions to medicine. First place must be given to his carbolized rabies vaccine, though his work on protective and therapeutic inoculations against enteric, diphtheria, snake bite and tetanus, mainly done as leader of a team, rank high for their value to the health of the British Army and as foundation stones for the work of others.

Sir David Semple died on 7th January, 1937, at the age of eighty. He was

of a very quiet and somewhat reserved nature, but a sound and reliable worker and a loyal colleague. His full worth was only known to a few who gained his confidence and had the privilege of his friendship.

LIEUTENANT-GENERAL SIR WILLIAM BOOG LEISHMAN was born in 1865, the son of the Professor of Midwifery in Glasgow. He qualified M.B., C.M., there in 1886 and was commissioned Surgeon A.M.S. in 1887. He served in India, 1890-1897. It is notable how many accounts of his life stress his having taken a microscope with him—an indication not only of their common absence from the baggage of medical officers, but also of their scarcity as items of military supply !

On his return to England he was posted to Netley for duty in the medical wards, and in 1899 he was appointed Assistant Professor to Wright in succession to David Semple. In 1903, on the move of the Army Medical School to London, he was selected to succeed Sir Almroth Wright as Professor of Pathology, a chair which he retained for nearly eleven years. This period from 1899 to 1913 was virtually his working life as a practising pathologist, as in October, 1914, he went to France as Adviser in Pathology to the D.M.S., B.E.F., and remained there until his return to the War Office in 1918 as Adviser to the D.G.A.M.S. In June, 1919, he became the first Director of Pathology and in July, 1923, D.G.A.M.S.

He died in office on 2nd June, 1926.

His principal contributions to medicine are three : the work on kala-azar, to which the devising of Leishman's stain was ancillary ; his improvement of anti-typhoid vaccines ; and his demonstration of the life cycle of *Borrelia duttoni* in the tick *Ornithodoros moubata*.

Chronologically, Leishman's stain comes first—the happy result of combining eosin and methylene blue rather than using them separately. An account of this work was published in 1901, but the stain was in use some time earlier, as it was the improved staining that it permitted which allowed his critical work on Leishman-Donovan bodies.

The latter he had found in 1900, not as an original observation, as they had been described though falsely interpreted at least twice before, the first occasion being by Cunningham in Delhi boil in 1885. Leishman's work was not published until 1903, almost simultaneously with that of Donovan, after he had noted the similarity of appearance between the parasites of trypanosomiasis in laboratory rats and those which he had found in human spleens in a number of cases of cachexial fever. He suggested that the human parasite (named *Leishmania* by Sir Ronald Ross in 1903) was an involuted form of the trypanosome. This combination of retentive memory application, coupled with imagination and refinement of technical method, seems to have been characteristic of all Leishman's work. It is illustrated again in his investigation of spirochætes, which began in an attempt to resolve, on morphological grounds, European from African species, with reference particularly to the organisms of syphilis, yaws and relapsing fever. This proved largely abortive, but in following up Dutton's work on the "granular phase" of *Borrelia duttoni*, he was able to

demonstrate the complete life cycle of this organism in *Ornithodoros moubata* (published 1909 with later papers in 1910 and 1911).

His third chief work was the improvement, so great that his obituaries, in 1926, referred to it still as "the perfection," of anti-typhoid vaccine. This research arose from the unfavourable reports on the vaccine in use during the South African War: it was a task for which his training under Wright fitted him well. The insight which led him to include paratyphoid organisms is well in keeping with his genius and his assiduity; and its results upon the health of the British and Allied Armies during the war of 1914-18 probably outweigh in value all his other work.

Lesser known investigations included "The Phagocytic Power of Blood" (1902)—strongly reminiscent of Almroth Wright; cell inclusions in blackwater fever; protective inoculation against influenza; investigations of tetanus and especially of tetanus antitoxin, and in his early Netley days diphtheria antiserum.

All this was his own personal research. In addition, he was during the same period teaching medical officers on first joining the R.A.M.C., and returning for the Senior Course, and it is clear that he did this uncommonly well. Every medical officer who joined the Corps between the outbreak of the South African War and the beginning of 1914 passed through his hands, and the uniformly high standard of attainment in his classes has been the subject of remark.

His obituary notices and recollections of him include references to his "lucidity of expression, charm of diction, disciplined imagination, and remarkable technical ability."

There remains only to consider his work in committee. He was an original member of the Medical Research Committee (later the Medical Research Council to which he was re-elected only a few months before he died); a member (1913-1915) of the Colonial Office Yellow Fever Commission; on the Scientific Advisory Committee of the British Empire Cancer Campaign; chairman of the Ministry of Agriculture's Foot and Mouth Disease Committee; and in strictly military circles, chairman of the War Office Committees on Trench Fever and Nephritis. These show a wide variety of informed interest.

With none of these has his name been specially linked in later years and his contributions to their deliberations are not now clearly discernible; it would, however, be out of keeping with the pathologist whose work still lives and with the administrator that as Director-General he showed himself to be, had they been insignificant.

The Science of Medicine and the Corps suffered an irreparable loss by the sudden death of Sir William Leishman. He died, while still in harness, from a gastric ulcer hæmorrhage. His disciplined imagination, intense love of truth, and tenacity of purpose enabled him to make discoveries which are known wherever the English language is spoken. His rewards and honours were many. His infinite tact, sane outlook and breadth of view enabled him to perform his duties as an administrator when Director-General with the greatest distinction. Such was the man who belonged to that small body of men who in little more than two decades built up what we know as modern Tropical Medicine.

## THE ARMY PATHOLOGY SERVICE

It was during the period preceding the 1914-18 war that the importance to the Army of a well-organized Pathology Service in the diagnosis, prevention, and treatment of disease was gradually becoming recognized, and the training of regular pathologists had been proceeding steadily, so that the number available at the outbreak of war was more than enough to fill the few pathology posts authorized.

*The First World War*

In the next or third stage, the war of 1914-18, the building-up of the Army Pathology Service saw the development of three types of laboratories in use in the field: (1) mobile bacteriological laboratories; (2) hospital laboratories, and (3) research laboratories. The mobile laboratory was something entirely new as bacteriological investigations had never before been carried out so near the front line in any previous war. These laboratories performed a most useful function in the carrying out of routine clinical pathology, carrier tests and investigations into new and little-known forms of disease, such as trench fever, spirochætal fever, gas gangrene and trench nephritis.

*Tetanus*

The first anxiety in this war was the unexpected prevalence of tetanus and gas gangrene, and tetanus was one of the early problems faced by Colonel Sir William Leishman on his appointment to the Expeditionary Force in October, 1914, in an advisory capacity. The incidence of tetanus had been negligible in the South African and Russo-Japanese Wars and it suggested that tetanus was unlikely to be an element of great importance, but in this war there were approximately 2,500 cases as a result of the fighting in France and Belgium, and the incidence was greatest in the early days. Incidentally, the incidence of 8 per 1,000 during the early months of the war was an incidence similar to that recorded for the northern theatre in the Franco-German War from 1870 to 1871. Anxiety was great and the War Office appointed a committee under the chairmanship of Sir David Bruce to investigate the problem. Prompt administration of a prophylactic dose of tetanus antitoxin to all wounded men was responsible for reducing the incidence of tetanus to about 1 per 1,000. It was clearly shown that serum prophylaxis prevented the onset of tetanus completely in at least five out of six men. Bruce calculated that some two million doses were administered in England alone, and it is worth recording that there were only eleven cases of anaphylactic shock, and not one was fatal. The high value of passive prophylaxis would appear to be the outstanding fact in the history of tetanus in this war.

*Gas Gangrene*

The second early cause of anxiety was gas gangrene, which also had been negligible in South Africa. It soon obtruded itself in unpleasant fashion at the battles of the Marne and the Aisne, occurring in 10 to 12 per cent. of the

wounded. Its ætiology was then unknown, and it rather tended to be looked on as a "hospital infection" until the investigation of Sir Anthony Bowlby and Sydney Rowland in one of the new mobile bacteriological laboratories proved that the gangrene occurring among the wounded was a "traumatic infection" originating at the time of wounding, that it was due to the entry of an organism from the soil, and that it was in no way related to sloughing phagedæna or so-called "hospital gangrene." It was not, however, until 1918 that antitoxic sera were available for use in the British Army, and then they were limited in scope and not very potent in effect. An efficient method of manufacturing the highly potent polyvalent serum, available to us in such generous amount during the recent war, had not then been discovered. But as a result of the work done at this time it was established that most promise lay in the use of serum in prophylaxis, that the serum should be active against several organisms of the gas-gangrene group, that it should be given as a routine, and that in treatment serum must be regarded as an adjuvant and not a substitute for efficient surgery.

### *Wound Sepsis*

The war of 1914-18 provided the first opportunity since the introduction of aseptic surgery of studying grossly contaminated wounds on a large scale. Suffice it to say that there were two distinct schools of thought, and much laboratory and clinical work was expended by both of them. One school placed its faith in "physiological" methods and rejected the use of antiseptics. Sir Almroth Wright was the protagonist of this school. Lorrain Smith and Dakin upheld the second school which trusted more in germicides of one kind or another.

### *Other Investigations*

Investigations were also carried out into wound shock, enteric group infections, bacillary dysentery, amœbic dysentery, typhus, trench fever, Weil's disease, and cerebrospinal fever. Army Medical Officers were awarded D.S.Os. for bravery when dealing with typhus fever in prisoner-of-war camps in Austria.

In 1916 paratyphoid A and B were added to the typhoid vaccine. This caused a marked reduction in the incidence of paratyphoid fever.

### *Chemical Warfare*

One is apt to overlook the important part pathologists took in solving problems leading to adequate defensive measures being taken to protect men against this weapon of mass destruction. Their work determined the pathological effects of the chemical agents in use and, working together with physiologists, they were able to determine the mode of their action, and to advise on the best lines of treatment. This led to pathologists becoming advisers on the medical aspects of chemical warfare, a position they have retained since that time.

### *The Inter-War Years, 1919-1939.*

The next stage is that of the inter-war years, when the pathology service was well established and pathologists had to undertake certain administrative duties. The war of 1914-18 had demonstrated the necessity for central direction

of pathology in the Army. Experimental procedures carried out in the preceding sixty-three years had become standardized. What were previously experimental procedures in immunology had now been accepted as routine practice. It was evident that in addition to purely laboratory work, military pathologists would have to undertake certain administrative duties connected with the prevention of disease. There was also a need to co-ordinate and supervise the training of pathologists and technicians. The Pathology Directorate was formed at the War Office in 1919, and Sir William Leishman, who had been adviser first in France and later at the War Office, was appointed first Director of Pathology. In the same year the Army Pathology Advisory Committee came into being—the chairman being the Director of Pathology. The function of this Committee was to advise the Director-General on all aspects of pathology and concern itself with fundamental inquiries into the origin and prevention of disease, rather than with work of a routine nature in connection with any one special condition. One of the original members was Professor Mervyn Gordon, best known for his work on cerebrospinal fever in the First World War. He died in 1953 at the age of eighty-one. This remarkable pathologist never missed one of the seventy meetings held during his lifetime—a truly remarkable feat.

The Director of Pathology is represented by senior administrative pathologists in all home and overseas commands—Assistant Directors of Pathology. These pathologists are in charge of the principal laboratory of the Command and are also advisers to the Director or Deputy Director of Medical Services in all matters pertaining to pathology. These officers are also responsible for supervising the training of pathologists and technicians.

During this period a great deal was done in reconstructing and building laboratories both at home and overseas—particularly in India, where the laboratories were of excellent construction and good design. Research work continued. Brigadier J. S. K. Boyd's classical work in India and the work of others on the dysentery bacilli placed our knowledge of the group on a firm basis. This work demonstrated the inadequacy of the previous system of classification and enabled a new and more scientific classification to be made.

Pathologists were closely associated with physicians in carrying out investigations which established the value of two drugs introduced by the Germans—plasmoquin and atabrin—in the treatment and prophylaxis of malaria. These findings were to be of inestimable value for the campaigns in the Far East in the war of 1939-45.

Military pathologists collaborated with the research work which led Colonel Shortt of the I.M.S. to establish the virus origin of *Sandfly fever*.

Two other important advances were made during this period: One, the value of selected virulent typhoid strains in vaccine production was demonstrated at the R.A.M. College by Lieutenant-Colonel (later Major-General) H. M. Perry and his co-workers. This was the result of a series of investigations carried out when the typhoid component of the vaccine—the Rawlings strain—which had been employed since 1900, came under suspicion a few years prior to 1934. The second was the development of tetanus prophylaxis by the use of tetanus toxoid.

Tests on dosage and the optimum interval which should elapse between doses were carried out by Brigadier J. S. K. Boyd at the R.A.M. College. Immunization prior to proceeding on active service was adopted and there is little doubt that this active immunization was responsible for the low incidence of tetanus in the Second World War.

### *The War of 1939-45.*

On the outbreak of war, a well-developed and efficient pathology service was in being. An adequate number of senior pathologists with administrative experience was available to co-ordinate and supervise the activities of the pathology service, which was greatly expanded by our civilian confrères. A special research organization was also established. Teams were formed from this organization as and when essential to investigate special problems. Laboratory facilities and equipment were provided on an as-required basis. Central laboratories with special consultants and facilities for research were established in all theatres of operations.

The Army Blood Transfusion Service under the direction of Sir Lionel Whitby will probably rank as an example of outstanding achievement in the Second World War. From small beginnings the Service developed into an enormous organization—blood transfusion from being a procedure confined to hospital practice was introduced to front-line units and given anywhere. New products were made, new methods introduced and new units formed to function in the great expansion of this service.

The Second World War is relatively recent, and the research work carried out by both U.S. and British Army pathologists, often working in collaboration, is so well known that it is unnecessary to do more than briefly refer to some of the problems investigated.

*Penicillin research* was well organized and co-ordinated between surgeons, pathologists and technicians; there must have been scarcely any laboratories at home or abroad in which the pathologist did not devote such time as he could spare at the bench to the practical study of penicillin in all its aspects. Their investigations form the basis of modern antibiotic therapy.

*Research teams* were formed to study shock, typhus, anaerobic infection, influenza, infective hepatitis, effects of heat, effects of immunization, diphtheria, and bacillary dysentery.

In *India* there was a remarkable expansion of the pathology service from a total of 27 laboratories in 1938 to a total of over 120 laboratories all over India and Burma. The volume of research work carried out was great. Valuable new information was obtained about nutritional anemia and sprue; the effects of malnutrition on repatriated prisoners of war and scrub typhus were among the host of subjects investigated.

I do not think that there is any doubt about the success and efficiency of the pathology service in the Second World War. Pathologists often carried out their investigations under conditions and with limited resources very reminiscent of the early pioneers.



I have been asked to say a few words about the Royal Army Medical College, where Army pathologists are trained. I have already mentioned that this College was first established at Fort Pitt, Chatham, in 1860 and moved to Netley, near Southampton, in 1863, where it remained until 1903, when it was transferred to London and occupied the present site in 1905. It is situated to the west side of the Tate Gallery, the military hospital being situated on the east side. There are fine laboratories for all departments and facilities available for research. Prior to the Second World War, vaccine production was carried out, but on the outbreak of war this department moved to the David Bruce Laboratories in the country (then called the Emergency Vaccine Laboratory). The College also houses a fine library. Attached to the College is the R.A.M.C. Headquarter Mess, which has also sleeping accommodation for some eighty officers. One of the most impressive rooms is the Victoria Cross Room. Here there is a painting of every Medical Officer who has won the highest British award for bravery under fire. The Medical Corps has won this decoration on thirty-one occasions, including two double V.Cs., the highest number in any corps or regiment—all won for saving life and very often awarded posthumously. It is a record we are very proud of.

#### *The Post Second World War Period*

In conclusion, I should like to say that this last decade of the century is in the post Second World War period, which I hope will not be another inter-war period. We have gone a long way in this 100 years, but I feel that the prime object of Service pathologists must always be, as it was, to assist in the prevention of disease and the treatment and care of the sick and wounded. It is not possible to comment at present on any accomplishments of this last decade. These must await the judgment of the future. One event of importance did, however, occur. At the end of 1947 service in India for the R.A.M.C. came to an end, and service pathologists have lost a valuable training ground.

The advent of weapons of mass destruction will only increase the responsibilities of pathologists and raise more problems which will, I am sure, be faced with the same success as in the past. But I should like to remind you that the capabilities of any pathologist are directly related to his technical background. I therefore in conclusion make a plea for pathologists not to become super-specialized in a narrow branch of the subject before they have an adequate background of medicine and pathology in all its branches. Let us take as our example the pattern of the work of the early pioneers.

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#### APPENDIX

WAR OFFICE,  
April 27, 1855.

SIR,

I am directed by Lord Panmure to transmit herewith, for your guidance, a Copy of the Instructions which have been drawn up with reference to the Pathological Researches about to be made by you in the Hospitals attached to the Army in the East.

I have the honour to be,

Sir,

Your most obedient Servant,

(Signed) B. HAWES.

DR. LYONS,  
&c., &c.

#### INSTRUCTIONS TO DR. LYONS

1. You will proceed without delay to Scutari, and report yourself, on your arrival, to the Commandant, Lord William Paulet, who will be apprised of the objects of your mission, and instructed to place you in communication with the principal Medical Officers of the Hospitals at Scutari.

2. You will have the entire and uncontrolled direction of the *post-mortem* researches on the bodies consigned to you for examination ; but you will be required to demonstrate the Morbid Appearances discovered to such of the Medical Officers as may feel disposed to attend. In order that these gentlemen may have the full advantage of your Pathological researches, you will arrange with the principal Medical Officer of the Hospital as to the time which will be most convenient to the Medical Officers to attend your demonstrations.

3. You will have under your directions two able Assistants (one First, and one Second), and both accustomed to and versed in the operations of the dead house.

4. As Morbid Anatomy is of little value unless studied in connection with the history of the disease, you and your Assistants will require to visit the Hospital wards in order to become acquainted with the symptoms and characters of the diseases

during their progress ; but you will not interfere with the treatment of the patients. In making notes of the cases, the name of the patient, and the number of his regiment, should always be stated, as by this means the nature of his duties, and the place where he was first attacked by disease can be more easily ascertained.

5. The Medical Officers of the Hospitals will be instructed by the principal Medical Officers to afford you every facility in visiting the wards ; and it is hoped that they will be able to supply you with notes of the symptoms and progress of the more urgent cases.

6. It is expected that you will not content yourself with the simple dissection of the subject, and the demonstration of the morbid parts, but that you will submit them to microscopical examination.

7. As you are provided with all the appliances necessary for your researches, it is expected that you will take full advantage of the opportunities which present themselves to prosecute your inquiries in this direction to the fullest extent ; and as you are also provided with the means of preserving such specimens of disease as you may deem necessary for the illustration of your researches, you will naturally avail yourself of them, and take the necessary steps for having them transported to England.

8. Although in all probability you will find at Scutari ample opportunities of completing your Pathological observations, you are not to confine yourself entirely to the Hospitals in that place ; should the information which you receive from reliable sources lead you to believe that more favourable opportunities present themselves in the Hospitals at Kululee, or elsewhere, on the Bosphorus, you may use your own discretion in transferring your researches, for a time, to such Hospitals, acquainting the Commandant of your intention, and the Superintendent of the Hospital you propose to visit.

9. With the view of rendering your researches more complete, it is desirable that you should observe the nature of the diseases of the Russian prisoners ; and it would further be desirable that you should visit the French Hospitals and ascertain the results of the researches of the French physicians in the diseases of their sick.

10. If, after having completed your researches in the Hospitals on the Bosphorus, you should be of opinion that you might acquire additional information, to render your researches more complete and useful, by observing the character and effects of the diseases prevalent in their earlier stages and more acute forms in the Crimea, you are at liberty to apply to Lord William Paulet for a passage for yourself and one or both of your Assistants and labourers to Balaclava ; upon obtaining his approval, you will, upon your arrival, report yourself and explain the object of your mission to the Head of the Medical Department of the Army in the Crimea.

11. Should your health unfortunately suffer so as to render you unable to continue your researches, you are to commit the charge of carrying them out to your first Assistant, giving him these instructions as his guide : and if he should require further assistance, application may be made to the principal Medical Officer at Scutari, or elsewhere, for such assistance, or to the Superintendent of any of the Civil Hospitals in the East.

12. In the event of either or both of your Assistants being unable, from sickness, to render you the assistance you require for the successful prosecution of your researches, you are to apply to the principal Medical Officer of the Hospital where

you may be for one or more assistants, or to the Superintendent of the Civil Hospitals in the East.

13. If, unfortunately, both yourself and your senior Assistant should be attacked by sickness, the circumstances should be immediately communicated to the principal Medical Officer at Scutari or elsewhere, or to Dr. Parkes, Superintendent of the Civil Hospital on the Bosphorus, who has one Assistant Physician at least capable of carrying out the Pathological researches on which you will be engaged.

14. As the office to which you are appointed is new in the Medical Department of the Army, it is possible, although not probable, that some difficulties may arise in the prosecution of your researches. If, by your own prudence and conciliatory conduct, you fail to overcome any such difficulties, you will apply to the Commandant of the Hospital at Scutari or elsewhere; and should he not afford you the support which you require, you will report the circumstances to the Secretary of State for the War Department with as little delay as possible. You will, however, under any circumstances report, from time to time, to the Secretary of State for the War Department the progress made in your researches.

15. When you shall have completed these researches, you will draw up a full report thereof, for the information of the Secretary of State for the War Department, to whom it should be addressed.

16. Although not strictly limited to time, it is presumed that a period of about four months will be sufficient to enable you to accomplish the object of your mission; as soon as you have so accomplished it, you will return to England without delay, in order to present the report of your researches to the War Department, it being important that no time should be lost in making known this report, as it may be the means of elucidating the nature of the diseases affecting the Army in the East.

17. On application to the Commandant at Scutari, a passage will be afforded you in one of the first Government vessels returning to England; and immediately on your arrival you will report the same to the Secretary of State for the War Department.

18. Should one or both of your Assistants desire to remain in the East, and should it prove that his or their services are required, the Superintendent of the Civil Hospitals will be authorized to employ his or their services, if he should think fit to do so. If, on the contrary, either or both should prefer returning to England with you, a passage will be afforded to him or them on application to the Commandant. The same option, with the approval of the principal Medical Officer, or Superintendent of any Civil Hospital, may be given to your two English porters, if willing to take the duties of orderlies, or if it be found that they can otherwise usefully be employed.

(Signed) PANMURE.

LONDON,  
April 27, 1855.

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COMPILED BY

M. DAVIES

*Librarian, Royal Army Medical College*

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*Original Communications***ENDOCRINOLOGICAL INVESTIGATIONS  
OF THE PSYCHIATRIC CASUALTY IN THE ARMY**

BY

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THE Army Medical Services are guided in the treatment and disposal of psychiatric casualties by the necessity to conserve manpower, not only qualitatively but quantitatively. The invaliding rate has varied between 10.8 per thousand in 1949 and 3.9 per thousand in 1953. One of the main roles of the Army Medical Services is, by advice and co-operation with all arms and services, to prevent the officer or other rank from breaking down. This is, in part, achieved by selection procedure at intake, and by the discharge of individuals referred either by personnel selection officers or by medical officers to psychiatrists, who find such to be unsuitable for service.

Over the post-war years accurate statistics have been kept of all recruits referred for psychiatric assessment, or who request psychiatric advice. Roughly 7 per cent. of the total recruits intake were seen by psychiatrists annually. Of this 7 per cent., those found fit and who required no reduction in M. and S. rating composed 60 per cent. ; some 20 per cent. were found fit for service but in a reduced medical category, usually S3 ; while 18 per cent. were recommended for transfer to the Royal Pioneer Corps in M3, and 2 per cent. were recommended for invaliding.

Thus only 0.15 per cent. of the intake are found unfit for service by psychiatrists, who therefore cannot be accused of invaliding out too many, and thus losing manpower to the Army.

Although these statistics must be regarded as satisfactory, there is still a necessity for a large psychiatric organization in the Army to meet the demands of those who break down during their service. In every Command where the British Army serves, special hospitals are provided for the psychiatric casualty who requires hospital treatment, while extensive out-patient services provide opportunities for psychiatrists to deal with the soldier at his job, and where many cases with minor mental disturbances can be treated and cured, without the necessity for admission to hospital.

The average annual turnover at the Royal Victoria Hospital, Netley, is about 1,200 per annum. Personnel who require in-patient hospital treatment are admitted from all overseas Commands and the United Kingdom.

There were 618 admissions for the period 1st January to 30th June, 1954, of which 44 were officers, 96 non-commissioned officers, and 478 other ranks. Those admitted from Commands in the United Kingdom amounted to 60.2 per cent., from the Middle East Land Forces 13.7 per cent., British Army of the Rhine 11.8 per cent., and Far East Land Forces 9.3 per cent. Of these total admissions, 64.5 per cent. were regulars, of whom 9.56 per cent. were officers, 21.47 per cent. non-commissioned officers, and 68.97 per cent. of them were other ranks. Only 35.5 per cent. were National Service personnel, of whom officers contributed a mere 2.01 per cent., non-commissioned officers 45.23 per cent. and other ranks 52.76 per cent. There is thus a slightly greater psychiatric casualty admission rate for regulars than for National Service personnel. Figures for regulars include only 50 re-enlisted personnel. Of the total admissions 55 per cent. were invalided from the service. An analysis of the period served in the Army prior to admission is as follows :

0—1 year	...	...	...	...	237
1—2 years	...	...	...	...	125
2—5 years	...	...	...	...	110
5—10 years	...	...	...	...	45
Over 10 years	...	...	...	...	101

Many of those who broke down in the first year were young, immature, timid personalities who had been brought up in a sheltered atmosphere and who had never been subjected to stress and strain in civil life and who found great difficulty in adapting themselves to service conditions. The vast majority of admissions fall into the descriptive diagnoses of anxiety states, hysteria, and schizophrenia.

We feel that although the above figures would bear comparison with any other psychiatric service in the country, there is no room for complacency, and that further efforts should be made to reduce, if possible, the invaliding rate. Many of these officers and men have excellent service records, and their loss must be considered a serious one to the Army. In this hospital all recognized psychotherapeutic investigations and treatment are carried out. These include all the accepted abreactive techniques, the use of Largactil, modified insulin therapy, electric convulsive therapy, and deep insulin coma. Treatment is dictated on careful clinical findings, both mental and physical, together with the medical history, school, work and service record of the patient, and his family history and environment.

Conservative methods relieve the presenting mental disturbance, but present clinical knowledge indicates that a re-occurrence is likely should the patient be retained in the service. Much thought has been given to this problem in the Royal Victoria Hospital, Netley, with a view to ascertaining whether more cannot be done to recognize disturbances of the total equilibrium which are at present clinically impossible to determine, but which may have a contribution in the etiology of mental disturbances and the treatment of these patients.

From the above figures over 50 per cent. of those invalided were within

the first two years of their service. These young soldiers were not only emotionally immature and maladjusted, but there appeared to be, in some, evidence of physical under-development. Accordingly the question of a physical basis to some psychiatric problems and a possible neuro-endocrine dysfunction must be suspected. It is felt that more could be done to enable these men to adapt themselves to Army life and thus prevent this considerable wastage to the Army in the first two years of service.

It is well recognized that many ductless glands have a direct influence on metabolic and other physiological brain functions and consequently on different phases of mentation. Furthermore, owing to the existing neuro-endocrine inter-relation, many acute and chronic psychological disturbances have an influence on the function of the ductless glands. It is, however, difficult to think in terms of primary and secondary phenomena when investigating a psychopathologic-endocrine problem, since the problem is only confronted by the psychiatrist when the pathologic process is already advanced, and a vicious circle has developed.

#### INVESTIGATION OF THYROID FUNCTION

Mental disturbances, often severe, have been recognized for many years in gross disorders of the thyroid gland. Various forms of psychosis have often been found in myxœdema, the psychosis being such a prevalent symptom that even the diagnosis of myxœdema has been frequently overlooked.

The need to consider myxœdema as a possible etiological factor in mental states has frequently been emphasized in the literature, since only thyroid treatment will provide an effective cure by attacking the basic pathological state (Stoll, 1932 ; Zondek and Wolfsohn, 1944 ; Asher, 1949 ; Miller, 1952).

Some mental patients suffer from myxœdema in which many of the classical features of the disease are absent, while others are seen with clinical conditions which obscure the underlying condition of myxœdema (Calvert *et al.*, 1954). Furthermore, laboratory investigations have in the past been unable to demonstrate doubtful clinical cases. The development of radio-active tracer methods in recent years has made it possible to detect unsuspected thyroid dysfunction on the basis of  $I^{131}$  uptake. Adjusting this method for use in psychiatric patients, Reiss *et al.* (1951) screened the thyroid activity of Bristol Mental Hospital's patients and found that on an average about 20 per cent. of the patients showed values outside the normal range. It was possible in this way to detect borderline thyroid disturbances in patients who did not show any other clinical signs of thyroid dysfunction. This seems particularly important when one realizes that it takes often many years before a thyroid underfunction becomes clinically recognizable with the development of skin and other changes. This method has also enabled the Bristol workers to discriminate between primary and secondary thyroid disturbances. Their results show that a particularly high rate of thyroid underfunction is to be seen in male anxiety states, while female anxiety states and acute female schizophrenics show frequently

hyperfunction. It was further possible to differentiate cases with real thyroid underfunction from those who showed normal thyroid activity but a reduced B.M.R., a discrepancy indicating decreased peripheral tissue sensitivity to thyroid hormone. The existence of such states has been repeatedly claimed in the past (Langfeldt, 1926; Hoskins, 1929), but can only now be detected with the improved methods. Such states of peripheral hormone insensitivity are now, as is commonly known, particularly important in young acute schizophrenics who show, according to our own experience also, other symptoms of peripheral hormone insensitivity. There are, for instance, young soldiers seen with completely normally developed genitals and androgen excretion who have no beard.

A statistically significant correlation was found between improvements of the previously disturbed thyroid function and mental improvement after different treatment procedures (Reiss *et al.*, 1953). The authors also report some cases who showed disturbed thyroid activity where treatment from the thyroid angle only led to improvement.

#### INVESTIGATION OF STEROID HORMONES

The relation of mental disturbances to pituitary adrenocortical activity has in the past years been the subject of much research. The administration of cortisone and corticotrophin has been held responsible for psychoses, not only when the dosage has been large and treatment prolonged, but also where very small amounts of these drugs have been administered. Severe mental disturbance has been associated with tumours of the adrenal cortex and also with Addison's disease.

More precise methods of assessing adrenocortical function by estimation of the twenty-four-hour urine excretion rate of the total 17-ketosteroids and their fractions, and of some corticoids, have in recent years indicated the presence of clinically hitherto unsuspected endocrinologic disturbances in mental patients.

Reiss *et al.* (1949) investigated the urinary steroid excretion in a case of manic-depressive psychosis. Their results showed that the onset of depression appeared to be accompanied by the excretion of a high proportion of the beta-fraction of the 17-ketosteroids, and a low cortin excretion rate, while the reverse change took place during the manic phase. They further noted that the inverse relationship between beta-steroids and cortin excretion remained a constant feature. These findings were confirmed by Bryson and Martin (1954).

In some cases with depression the increased beta-ketosteroid excretion rate can be reduced by treatment with testosterone, a change usually accompanied by some improvement of the depressive state (Reiss, 1953).

Hemphill *et al.* (1950) have found evidence of abnormal responsivity of the adrenal in schizophrenia and other forms of psychoses, and their results in schizophrenics have been confirmed by Hoagland (1953).

Strauss *et al.* (1952) have reported improvement in some schizophrenic patients treated with dehydroisoandrosterone, the main component of the beta-fraction of the 17-ketosteroids. The majority of these cases showed abnormal



urinary excretion of 17-ketosteroids with predominantly subnormal beta-fraction, indicating one aspect of adrenocortical activity. In some patients the drug appeared to increase self-confidence and induce euphoria, while in others with prominent delusion-formation it tended to increase aggressiveness and nervous tension. The authors suggested that dehydroisoandrosterone might be of value in constitutionally inadequate and anxious juveniles with a tendency to schizoid psychopathy.

The report of Sands and Chamberlaine (1952) seems to confirm the value of this drug in the treatment of inadequate personality in selected patients. Those who were emotionally inadequate gained by becoming more normally confident, alert, and able to mix with their fellows. Those liable to be over-aggressive were made worse and appeared over-stimulated by the drug. Their results indicate that further research is required into selection and dosage before definite conclusions can be reached.

Much has been written on the use of œstrogen in the treatment of sexual offenders as a form of chemical castration to reduce excessive libido (Golla and Hodge, 1949). Recent research (Sands, 1954) in patients with various forms of abnormal sexuality indicates that there is a definite improvement in the patient's preoccupation and worry over his affliction, accompanied by a decrease in the obsessional sexual urge. Swyer (1954) also finds that œstrogen reduces the sexual urge, but does not alter its direction. It therefore has the effect of rendering an uncontrollable urge controllable, and thus prevents the individual from falling foul of the law.

#### APPLICATION OF ARMY PSYCHIATRY

In the past, attempts have been made to relate biochemical and endocrinological disturbances to mental illness, the results of which have often been inconclusive. Claims made concerning glandular dysfunction and results of prescribed treatment, based on these findings, could not be substantiated, since unreliable methods were used, or reliable but crude methods were used which did not give significant results. Adequate controls for age and sex have seldom been obtained, while the follow-up of results has been difficult. It is considered that these problems can be overcome in the Army, and suitable controls obtained against which results can be validated, while follow-up during service should be possible.

Only in recent years have some laboratory methods been developed which enable us to detect intermediate and borderline endocrine changes preceding, accompanying and following psychologic changes. The use of isotopes and improved chemical methods permit quantitative measurements of some hormones and of hormonal action in a more precise way than hitherto.

It is evident from the literature that no specific endocrinological changes have been found in either the psychoses or neuroses. Different psychopathological states are found under identical endocrinological disturbances in

psychiatric cases, which up to now have been considered "identical entities." It is clear, however, that a normal functional equilibrium of certain ductless glands is essential for normal mentation. The connection between psychiatric illness and endocrine disturbances does not prove that the endocrine dysfunctions cause the psychiatric illness. The mental abnormalities may well be the cause. There is no doubt, however, that in many patients the normalizing of the endocrine disturbances by appropriate treatment is associated with the recovery of the mental condition.

These studies of research work carried out in England and America on endocrine function and psychopathological states, and the discussions with psychiatrists and endocrinologists in London, Epsom and Bristol, indicate that endocrinologic investigations may at some future date provide a basis for a more correct clinical assessment, and improved treatment for the psychiatric casualty in the Army.

It is apparent that such investigations must be correlated with clinical findings and a rationale of any treatment established only after all facts have been put together.

The proper investigation of the psychiatric casualty can only be satisfactorily achieved by the combined efforts of the psychiatrist, endocrinologist,\* pathologist and psychologist. Without this appropriate collective investigation, factors may be missed to the detriment of the patients, who may as a result have to be invalided from the service, and thus become a loss to the Army. It must be emphasized, however, that hormonal therapy must never be given to a patient unless and until there are definite indications for such therapy. Such treatment may replace certain factors lacking in the patient, but it can never be regarded as a substitute for a full psychiatric investigation and proper psychotherapeutic measures, though progress in psychotherapy can be accelerated through improved support. The use of endocrines in appropriate cases does, however, facilitate psychotherapy and hasten the recovery of many patients who would remain unaffected by conservative methods of treatment.

It is considered that endocrinological investigations may provide us with some essential pathobiological explanation for the development of some mental diseases. Work has already commenced on these lines. Some interesting results have been found which will be published in due course.

Inadequate personality types form a large number of psychiatric referrals to out-patient clinics in the Army and of admissions to the Royal Victoria Hospital, Netley. Co-operating with Drs. E. B. Strauss and W. A. H. Stevenson of St. Bartholomew's Hospital, Dr. D. E. Sands of St. Ebba's Hospital, and Dr. Max Reiss of Bristol, plans have been made to carry out investigations into carefully selected service patients admitted to the Royal Victoria Hospital, Netley.

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## SUMMARY

A clinical survey of psychiatric casualties admitted to the Royal Victoria Hospital, Netley, is made. Statistics showing admissions rates and disposal are given.

The unsatisfactory results of recognized empirical methods in some cases is indicated, even though all available modern methods have been applied.

Recent publications and researches on the use of endocrines in mental states are briefly reviewed.

The proper assessment of each case and a rationale for treatment based on clinical, endocrinological and pathological findings are emphasized.

Endocrinological investigations being carried out on immature personalities and other psychiatric disabilities in the Army are mentioned.

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# A COMPARATIVE PHYSIOLOGICAL TRIAL OF FOUR TYPES OF PERSONAL LOAD-CARRYING EQUIPMENT

BY

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## INTRODUCTION

FROM time immemorial the soldier has carried his knapsack over a shoulder or on the back. It cannot be said, however, that the advantages of an upright posture have as yet made him into an efficient beast of burden.

The pack animal, on the other hand, is deliberately trained for portage; it largely exercises its own will with regard to the speed of travel, and is protected by the load being normally limited to less than a quarter of the body weight.

By comparison, the soldier is poorly treated. Portage, which may on occasion play a major part in his activities, is completely subordinated to his operational role. His upright posture makes him a very poor animal for load carriage; nevertheless he is still expected to carry at least a third of his own weight, and this he must do from the small platform of his feet through which gravity acts. Although stability is of paramount importance, antero-posterior balance is often neglected or may be difficult to obtain, and by reason of his having to carry a rifle or other weapon, lateral symmetry may well be impossible. The soldier must be able to see well, turn rapidly, and move with changing speed and direction. Military requirements are constantly at conflict with physiological principles. Thus one must consider problems of silhouette, manœuvrability, accessibility of items of equipment, and changing types of warfare. The best that can be hoped for in his method of load carriage is an acceptable compromise, in an equipment which meets the overriding operational requirements with minimum sacrifice of the physiological principles which make for ideal load carriage.

The turning point in the development of personal load-carrying equipment in the British Army came with the work of Parkes (1) and the Committee of 1865-1868 (2), as a result of which the following principles were enunciated:

- (a) The weight to be distributed over a wide area of the body;
- (b) Weight of the knapsack behind to be balanced by the pouches in front;
- (c) All loads to be close to the body and near the centre of gravity.
- (d) No compression to be allowed in the armpit or chest; and
- (e) The total load to be of the order of 45 lb.

These various principles were combined in the first valise equipment of 1871, in which the valise was supported by the shoulders and hips (2).

Considerations of the background of the problem suggested that a preliminary approach should consist of an attempt to assess, under laboratory and field conditions, the physiological stresses imposed by four available types of equipment, and to examine critically the techniques of measurement with a view to their improvement.

## METHOD

### *General*

The trial was divided into three phases : (a) validation field trial in which the measurements themselves were assessed ; (b) a main field trial in which the four equipments were compared in battle order ; and (c) a laboratory trial in which equipments were again compared in battle order.

### *Equipment on Trial*

*1937 Webbing Equipment.*—This is a form of brace system in which the load is carried high on the back, and represents a lighter version of the 1908 equipment used in the First World War. The weight is supported mainly by the shoulders.

*The Assault Jerkin.*—The jerkin distributes the load well, decreases pressure points, and because of frictional effects clings to the body. The earlier criticism of undue heat stress was met in the present trial by the use of a “leno” type weave of nylon, of open but strong construction.

*The Bergen Rucksack.*—A rucksack has for long been used by the Scandinavian infantryman, and is generally assumed to be suitable for hill climbing. It consists of a metal frame applied to the back and hips, and supports a capacious bag. The load is borne mainly by the hips and is not normally counter-balanced in front. The frame allows of ventilation near the back, but maintains the centre of gravity of the load distant from the spine. Hence, with a heavy bulky load, some flexion of the spine—a disadvantage for the soldier—is required to maintain equilibrium. Marching is associated with a wobble of the bag, particularly with change of speed and direction, and the annulment of the relatively high angular momentum of the load, by pressure on the tissues and muscular effort, is productive of discomfort and wasteful in body energy.

*The Z2 Experimental Equipment.*—This is an outcome of the work of Lippold and Naylor (2), and consists in principle of a long pack closely adapted to the back. In practice, the weight is borne mainly by the shoulders. The equipment is best adapted for battle (fighting) order, but the insertion of a triangular container converts it into marching order. Photographs and other details of the above equipments were given in a previous communication (2).

### *Loads Carried and Clothing*

In both laboratory and field trials, all subjects wore battledress blouse and trousers, with shirt, undervest and pants ; socks, boots G.S. and anklets. Steel helmets (weight 2 lb. 9 oz.) were worn, and respirators, light (2 lb. 9 oz.), kept in the approved position.

In both the main field trial and the laboratory trial, all men carried full battle order. This consisted of the above items, with rifle and bayonet (9 lb. 3 oz.), 100 rounds of .303 ammunition (6 lb. 3 oz.), two "36" hand grenades (2 lb. 12 oz.), three Bren magazines loaded with 28 rounds (7 lb. 13 oz.), entrenching tool (4 lb. 1 oz.), water-bottle filled (3 lb. 5 oz.), ground-sheet (2 lb. 15 oz.), mess-tin and holdall (2 lb. 9 oz.), one pair socks (4 oz.), hand towel (7 oz.), and water sterilizing kit (4 oz.). The mean weights carried in battle order are summarized below :

TABLE I

Equipment	Weight empty	Load within or attached to equipment	Total load in battle order
1937 Web ... ..	4 lb. 5 oz.	24 lb. 6 oz.	50 lb. 2 oz.
Jerkin ... ..	4 lb. 8 oz.	24 lb. 6 oz.	50 lb. 1 oz.
Rucksack ... ..	6 lb. 12 oz.	24 lb. 6 oz.	52 lb. 5 oz.
Z2 Experimental ...	6 lb. 8 oz.	24 lb. 6 oz.	52 lb. 1 oz.

In the validation trial men wore either the rucksack or Z2 loaded to weigh 18 or 48 lb.

### *Test Subjects*

Sixteen men, including two lance-corporals, who had just completed their period of training, were made available for the whole trial, covering in all a period of one month. The men cannot be regarded as a random sample, but from the viewpoint of the trial may be accepted as representing average National Service men. From the sixteen men, eight were chosen by a random process and became the test subjects. The rest were included in all activities in order to add military reality, and carried loads similar to those of the experimental subjects. An officer was in command of the twenty-eight-hour period of field duty (see below) and a sergeant in charge under other conditions. Four men of the group were used in the laboratory trial.

### *Details of Work Sessions*

To make the test subjects feel less conspicuous with their equipment and with a view to keeping their attitude to the trial as near normal as possible, the eight subjects worked within the group of sixteen men on all the field activities. A preconditioning period of seven days, with work sessions in the morning and afternoon, was allotted to allow the men to become foot-hardened as well as body-hardened to carrying a load, and acclimatized to the rubbing and chafing due to the equipment. It was realized that a week was probably insufficient for preconditioning, but it was the maximum time available. The various types of work session were staggered over the twelve available working days to make a balanced trial. This gave a variety of work from day to day and allowed the effects of the three types of activity on the wearers of the equipment to be compared. Within the limitation of group military activities, all men did the same work over the same period of time.

The validation trial took four days, with a work session each morning and afternoon. The first two days were concerned only with measurements of the rifle fire performance test. Each work session commenced with the rifle fire grouping practice, and this was repeated at the end of the periods of work. On the second two days, physiological measurements (see below) and performance tests—sand-shovelling and Bren magazine—were carried out before and after each work session. Work sessions consisted entirely of marches of three hours' duration. The following activities were carried out during the field or laboratory trials :

(a) *Three-Hour Marching*.—This represented fairly severe work in which men were marched without rest at a rate of three miles per hour approximately. During the work periods, natural obstacles had to be surmounted in rough cross-country travel ; barbed wire fences, rough high grass in marshland, and short slippery slopes were utilized to the full. There were four such periods in the validation trial and four in the main trial.

(b) *Six-Hour Marching*.—This was a normal road-marching period at a rate averaging two and a half miles per hour, with a ten-minute halt in every hour and with a break of half an hour for a meal in the open. Routes were varied to avoid monotony, but chosen to give comparable muscular fatigue. The distance marched was thirteen miles in all cases, five miles of which were cross-country. Use was made of paths, but the greater part of the routes was on hard tarmac roads. There were four periods of six hours' marching in the main trial.

(c) *Twenty-eight Hours' Continuous Duty*.—This was planned to produce the conditions of the other two work sessions, and to add the fatigue of simulated battle following a tiring night with little sleep. The exercise represented an approach to contact, with overnight bivouac and a dawn attack. It began at the laboratory with resting physiological measurements and the sand-shovelling and Bren magazine performance tests. The subjects were then conveyed in transport to the rifle range and carried out the rifle performance test. Embussing, they were conveyed twelve miles away, and the officer in charge was given the narrative that he was on an approach march to contact. He was given a rendezvous with transport (for food, tents, picks and shovels, etc.) and a likely bivouac area, and briefed to make the exercise as realistic as possible, with proper march discipline, a defence layout of the bivouac area, regulation slit trenches and suitable camouflage. Guards and night patrols were arranged to give comparable exercise for all the test subjects. The average sleep obtained during the exercise was about two hours. At dawn the troops moved in through difficult country to the attack, being harassed by simulated enemy fire, and finished the exercise with a seventy-yard charge on to the objective—the firing point of the rifle range—where the men “shot it out with the enemy.” Troops were then relieved and marched back to the laboratory where all measurements were repeated. In all there were three sessions of twenty-eight hours' continuous duty during the main trial.





MEN AT THE END OF A 13-MILE MARCH



THE SAND-SHOVELLING TEST



(d) *Treadmill Walking in the Laboratory.*—Men walked on a horizontal treadmill for thirty minutes at a rate of three miles per hour. This activity corresponded most closely in intensity to the six-hours' march.

### *Measurements*

1. *Physiological.*—Rectal temperature by clinical thermometer (five minutes) and pulse rate at the wrist were taken in the upright position after about thirty minutes' rest, and immediately at the end of the various work sessions in the laboratory and field. In the laboratory trial, expired air volume was taken over two consecutive five-minute intervals at the end of the treadmill walk, using a standard Douglas bag technique. The value of such measurement as an index of work metabolism has been described elsewhere (3). The nature of the field trials precluded measurement of sweat loss or skin temperature. Men were examined by a medical officer, before and at the end of the various work periods, for evidence of chafing or bruising.

A daily pre-work questionnaire designed to assess fatigue or discomfort of the previous day's activity was given to the men. Another questionnaire, involving simple three-point scales of subjective sensation, was used before and after each period of work. The scales covered the sensation of warmth (viz., comfortable, warm, hot), sweatiness (dry, sweaty, very sweaty), fatigue (fresh, tired, exhausted) and chafing (none, little, much). A similar scoring system was used for body aching, fit of equipment, balance of equipment and foot comfort.

At the end of the whole trial, the experimental subjects were asked to rank the equipments in order of preference. Opinions were also taken from two men who had experience of all the equipments in the various work sessions and had acted as spare men. The preference questionnaire was repeated after each subject had been separately warned that the results of the trials might be inconclusive, in which case another work period would be required of much greater intensity than anything already done. Forgetting any ranking they had already given, each subject was asked his first and second choice in such an eventuality.

As a matter of interest, men were asked at the end of the trial to rank each other independently in order of "military fitness," as shown by their general demeanour and activities during the month's trial. This was done by the subjects themselves and by three unbiased observers.

2. *Performance Tests.*—Three performance tests, simulating ordinary activities of the soldier, were used in the hope of throwing further light on differences between equipment or loads. These tests consisted of: (a) Sand shovelling: the men had to fill with sand and empty as fast as possible a standard bucket eight times. (b) Men emptied and reloaded twice, as fast as possible, a Bren magazine. Tests were done at the same place, before and as soon as possible after return from field activity. Each man was individually timed by a stop-watch, but tests were carried out on the men as a working group. (c) Rifle fire on a rifle range: two lots of ten rounds were fired in grouping practice on two targets in quick succession.

3. *Further Tests and Observations.*—(a) Distribution of the loads carried in battle order was measured laterally and antero-posteriorly.

(b) Water uptake and drying times. Each equipment was weighed dry, and then completely immersed in water for three minutes. On removal from the water, pockets were emptied and equipments hung up to dry in the open. The weight was taken when the rate of dripping fell below one drop per second, and successive weighings done until the original weight was recorded.

(c) Photographs were taken and cinematography carried out as a routine during the various field activities.

(d) Environmental measurements. It was not possible to carry out the laboratory experiments in a conditioned room, but fairly constant levels of temperature, humidity and air movement were maintained in a large laboratory.

Under field conditions, wet and dry bulb readings were taken periodically; wind speed measurements at  $4\frac{1}{2}$  feet were recorded over hourly periods and averages calculated.

### *Design and Analysis*

In order to make full use of the measurements taken and to minimize bias due to inherent differences between men and to the fact that measurements were not all taken at the same time, a statistical design of experiment was used into which all the measurements could be suitably fitted. Primarily, the design ensured comparable opportunity for each man with each equipment in the same work experience.

The object of the validation trial was an attempt to investigate the ability of some of the methods used, to differentiate between a handy light load and a fairly awkward moderate load. It was of interest also to gather some information of the effect of loads, independent of equipment. The Z2 and rucksack were loaded to weigh either 18 or 48 lb.

A  $2 \times 2$  factorial design arranged as two Latin squares was used for the validation trial. The squares taken together represented a random arrangement of the heavily and lightly loaded equipments allotted among eight subjects in four similar work sessions, thus giving thirty-two experiments for the four types of combination (Z2 equipment, heavy and light; rucksack equipment, heavy and light) or eight experiments for each load/equipment combination.

In the main trial, a design was used enabling the three types of activity to be analysed separately or conjointly. For each of the three- and six-hour periods, two Latin squares were used. Lack of time enforced the use of two Youden squares (4) for the twenty-eight-hour work periods, since each of the latter involved two working days. This arrangement gave eight experiments per equipment for the three-hour and six-hour sessions, and six for the twenty-eight-hour periods. In total there were twenty-two experiments for each type of equipment over all forms of activity.

For the laboratory trial, a combination of two  $4 \times 4$  Latin squares was used, giving eight experiments per equipment. Data obtained from the Latin squares

were examined by analysis of variance. This allowed the total variation in the mass of data to be subdivided into its component parts, viz., man to man, session to session, work to work, equipment to equipment, load to load, etc. Certain interactions of interest, viz., equipment  $\times$  weight, were also separated. Many of the objective data were analysed as both post-work and post- minus pre-work measurements.

Subjective data of post-work sensation scores were analysed by the  $\chi^2$  test. The results of the preference questionnaire were analysed and Kendall's coefficient of concordance calculated (5). The results of the subjective "military fitness" ranking and related data of interest were analysed by the technique of rank correlation, and Kendall's  $\tau$  and Spearman's  $\rho$  calculated (5).

For brevity, only the more pertinent data and tables are included in the present paper.

## RESULTS

### Validation Trial

The results were analysed in the form of both post-work and difference (post- minus pre-work) readings, but only the former are tabulated here. Table II gives the consolidated results from variance analysis.

TABLE II.—VARIANCE ANALYSIS—POST-WORK MEASUREMENTS—EIGHT OBSERVATIONS PER EQUIPMENT/WEIGHT COMBINATION

Equipment/Measurement	Pulse rate	Rectal temperature	Bren magazine	Shovelling
Between heavy and light load	$P < 1\%$ Significant	Not significant	Not significant	$P < 5\%$ Significant
Between Z2 and rucksack	Not significant	Not significant	Not significant	Not significant
Interaction Equipment $\times$ Load	Not significant	Not significant	$P < 5\%$ Significant	Not significant

With the pulse rate, it is noted that it has been possible to distinguish between the effect of an 18-lb. and 48-lb. load, but not between the equipments (even at the 10 per cent. level of probability). No significant difference was found between loads or equipment in final rectal temperature at the 5 per cent. probability level, but significance was present between equipments at the 10 per cent. level. The shovelling test showed a significant difference between loads, but not between equipments. Results of the Bren magazine test showed no significant difference between loads or equipments, but the significant interaction term suggests that the increase of weight affected the use of the rucksack more adversely than that of the Z2 equipment.

Examination of the means for these two performance tests shows that post-work were usually better than pre-work scores, *i.e.*, the tests did not appear to be a valid measure of fatigue. This matter is discussed later.

It was unfortunate that the subjects, National Service men, engaged in the trials were, in spite of the records in the A.B. 64, so inexperienced that results from the rifle test could not be analysed satisfactorily because of the large



number of misses. There were, however, indications that the test would distinguish between heavy and light loads, but not between equipments.

It may be concluded that the tests were not able to distinguish between the two equipments, but pulse rate and sand shovelling showed significant differences between packs loaded at 18 and 48 lb.

### *Main Trial*

The means and standard errors for both post-work pulse rate and post-minus pre-work pulse rate are given in Table IIIa (page 145,) analysed separately for the three forms of work activity. Table IIIb gives results of variance analysis for post-work measurements only.

Analysis of data obtained from the above tables shows that the appreciably lower post-work pulse rate for the Z2 equipment in the three-hour march session is significantly different from that of the other equipments. Significant difference between equipments is, however, absent for the six-hour march period. Data from the twenty-eight-hour continuous duty show almost significant difference between equipments. Further examination demonstrated that the lower pulse for the jerkin is significantly different to that of the other equipments almost at the 5 per cent. level of probability. Analysis of variance showed that over the whole trial there is a significant interaction of equipment  $\times$  type of work. This would again suggest that the different kinds of equipment may be suited to different kinds of work. In the case of differences between men and between sessions, highly significant differences were present for both resting and final pulse rates.

Table IVa gives means of rectal temperatures for the various work activities, and Table IVb the results from variance analysis of final rectal temperature. In the analysis of the twenty-eight-hour session with data derived from Youden squares, the "between equipment" effects have been adjusted for differences between men. This was done to compensate for each man not having equal opportunity with each equipment. Despite balance being only partial, valid comparisons between equipments are obtained.

Differences between means are all negligible, and there is no significant difference between equipments for the three types of work activity or of these combined. It is noted that the difference between men is significant for the three-hour, six-hour and total period, but not for the twenty-eight-hour exercise. Since an adjustment was not made for man-to-man effects, the comparisons are not strictly valid. A significant "between session" difference is present for all types of work activity and there was interest as to whether this was due to some learning or other acclimatization factor. However, analysis showed the absence of a significant regression. One may therefore presume the difference to be related to day-to-day vagaries of the weather or other uncontrollable factors.

Results from the subjective data are tabulated below (Table V) :

TABLE V.—POST-SESSIONAL SUBJECTIVE SENSATION SCORES

Questions	$\tau^2$	Significance	Remarks
1. Warmth ... ..	1.73	Not significant	
2. Sweatiness ... ..	2.72	Not significant	
3. Tiredness ... ..	8.82	Not significant	
4. Ability to repeat the course. "Yes" or "No"	6.49	$10\% > P > 5\%$ Nearly significant	An almost significantly greater proportion of men wearing the 1937 web gave answer "Yes" than for other equipments.
5. Chafing ... ..	16.30	$P < 0.5\%$ Highly significant	The rucksack and the jerkin chafed the skin significantly more than the Z2 experimental or the 1937 web.
6. Body aches ... ..	2.70	Not significant	
7. Balance ... ..	40.87	$P < 0.1\%$ Highly significant	The rucksack upset bal- ance significantly more than the other equip- ments.
8. Soreness of feet ...	5.14	Not significant	
9. Fit of equipment	$\tau^2$ could not be calculated due to the almost unanimous opinion that all of the equipments fitted well.		

It is seen that subjective sensation scores show no significant differences between the four equipments with regard to making the men feel hot, sweaty, tired; to body aching, sore feet, or to fit of the equipment on the body. Men were of the significant opinion that the rucksack and jerkin chafed the skin more than the other two equipments, and that the rucksack upset body balance more than any of the others. There were also complaints of chafing in the groin by the pouches of the Z2 equipment, and of the shoulders in the 1937 equipment. A seeming incompatibility appears to arise between the answers to questions 3 and 4. Only six "not tired" answers were obtained from the 35 questions put to the men after wearing the 1937 webbing. This is in contrast to the 16/35 affirmative statements that they could go over the course again wearing this equipment, suggesting that at least ten tired or exhausted men could go over the course again immediately after heavy work. Such a result may be explained in terms of lack of validity in the method of scoring; the term "tired" may not be sufficiently discriminatory between the onset of tiredness and the verge of exhaustion; and the men may belong to a class who were only slightly tired, but not of the class "not tired." On the other hand, greater familiarity with the 1937 webbing perhaps made them better judges of their own strength in the sense of the further work they could do, even though tired.

Analysis of the preference questionnaire taken at the end of the trial gave Kendall's coefficient of concordance  $W=0.508$ ,  $P < 1\%$ , *i.e.*, there was significant agreement among the subjects. Their ranking of preference was as follows:

- |                                |                   |
|--------------------------------|-------------------|
| (1) Z2 experimental equipment. | (2) The jerkin.   |
| (3) The rucksack.              | (4) 1937 webbing. |

Analysis of data from the "military fitness" ranking by Kendall's coefficient of concordance gave  $W=0.47$ ,  $P<1\%$ . It was felt that this ranking was one of "fitness" mixed with popularity, and friends were inclined to put each other first. However, there was significant rank correlation between the rankings of three observers and the subjects themselves. Spearman's coefficient gave  $\rho=0.85$ ,  $P<1\%$ . As a matter of interest, ranking correlations were calculated between the fitness ranking and the order of merit as assessed by the sand shovelling and Bren magazine performance tests. Both Kendall's  $\tau$  and Spearman's  $\rho$  were used. A significant positive correlation was obtained between the fitness ranking and the performance tests. Results are tabulated below.

TABLE VI.—RANKING CORRELATIONS—"FITNESS" AND PERFORMANCE

"Fitness" and sand shovelling	$\tau=0.57$ , $P<5\%$ $\rho=0.79$ , $P<5\%$	Significant
"Fitness" and Bren magazine test	$\tau=0.57$ , $P<5\%$ $\rho=0.74$ , $P<5\%$	Positive correlation

The above results fit in with the hypothesis that experience may, under certain conditions, be as good or a better criterion of judgment of "military fitness" than conventional laboratory performance tests.

Both pre- and post-work results were analysed separately for the rifle fire test. It was reasoned that analysis of pre-work results might indicate whether one type of equipment interfered more with the use of a rifle than another type. Analysis of the post-work results would perhaps indicate such an effect, plus the varying effect of fatigue due to marching with a loaded equipment. Various considerations suggested that logarithmic transformation of grouping diameter was most suitable for analysis. Variance analysis of transformed pre- and post-session firing scores showed absence of significant differences between equipments and between sessions. In the case of man-to-man difference the results gave  $P<5\%$  for pre-session and  $P<0.1\%$  for the post-session scores. Absence of significant differences between sessions suggests absence of a learning factor, and in using such a performance test a simpler design could be utilized which ignores the "session variable."

With the other two performance tests, variance analysis was done on the means of post-session scores for the three-hour, six-hour and twenty-eight-hour activities. None of the analyses showed significant difference between equipments for either test. However, in both tests a significant difference between men was found for the three types of work and for all work combined ( $P<0.1\%$ ). A significant "between session" difference was present for both tests, and since a gradual fall in mean times was found over the trial, it may be assumed that for these two particular tests a learning factor was present. This is to be compared with the results obtained with rifle fire. As a matter of interest, a correlation coefficient was calculated between final pulse rate and final Bren magazine performance test. The coefficient was negligible.

*Laboratory Trial*

The results are summarized in Table VII below.

TABLE VII.—MEANS (EIGHT EXPERIMENTS) AND STANDARD ERRORS

Measurement/Equipment	1937 Web	Jerkin	Rucksack	Z2 Experimental
Respiratory Volume (litres per minute) ...	35.4±0.68	36.3±0.68	36.9±0.68	37.3±0.68
Post-work rectal temperature °F. ... ..	100.0±0.1	99.9±0.1	100.2±0.1	100.1±0.1
Post-work pulse per minute	127±2.9	119±2.9	128±2.9	126±2.9

It is noted that in minute respiratory volume the 1937 equipment showed the lowest mean, but differences are only of the order of 5 per cent. or less. In the case of final pulse rate, the jerkin gave appreciably lower figures. However, none of the above differences is significant at the 5 per cent. probability level, although significance at the 10 per cent. level is present for the difference between maximum and minimum means for ventilation volume. The treadmill walking corresponded in activity level most closely with the six hours' field marching. It is to be pointed out that the former was only of half an hour's duration, and with exertion the rectal temperature often requires up to an hour or more to stabilize.

*Other Observations*

Water uptake and drying times for the four equipments showed that the Z2 equipment took up most water and took a very long time to dry—about seventy hours compared with the four to five hours for the other equipments. It appears that absence of water exit holes in the Z2 equipment was the main cause of the differences encountered.

Examination of the component parts of the four equipments from front to back and side to side showed the jerkin to be best balanced and the Z2 equipment second best. The rucksack has such a preponderance of weight at the back that a forward stoop is inevitable. Cinematography was carried out during hill climbing, crawling, running, rolling down hill, jumping and standing. It was clear that the only bad silhouette was that when wearing the 1937 equipment. There was little to choose between the others. Posture in marching is normal with all equipments except the rucksack. This gives a particularly wobbly load and is least suitable for military activities. The most stable equipments, in the sense of clinging to the body during most activities, were the Z2 and jerkin. Direct observation and cinematography repeatedly showed that one of the most important features of a good military load is stability on the wearer and freedom of leg action. Movement of the load when the man is in motion is, quite apart from accompanying chafing, mentally irksome and tiring to the wearer. When wearing a rucksack in the prone position, it is difficult, even with the helmet off, to get the head far enough back to fire comfortably. When the helmet is in position, it is practically impossible to use the sights, since the top



of the rucksack butts the rim of the helmet. The jerkin, with its high pouches, made it difficult to fire in the prone position. With all equipments, crawling was difficult because of the chest position of the respirator. It is here to be stressed that in problems of military load carriage, all personal equipment carried into action should be taken into consideration.

#### DISCUSSION

The results of the present investigation show that with soldiers loaded in battle order, none of the four equipments under trial occasioned physiological strain as measured objectively or subjectively. Differences were found between equipments in the various measurements used, but rarely passed the critical eye of the significance test.

The only objective test which showed significant differences was the pulse rate. Analysis suggested that the Z2 equipment is more suitable for a gruelling march and the jerkin more adapted for the twenty-eight-hour session. The finding of a significant equipment  $\times$  type of work interaction has a similar implication. Significant differences in pulse rate were, however, not found in the treadmill experiments, and the findings of Daniels *et al.* (6) are similar. Long marches over variable and difficult terrain and with change in speed and direction of the body may show up defects in an equipment and introduce physiological and psychological strains which do not arise in the uniform short walks on a laboratory treadmill. A treadmill is furthermore not suitable for use by a group of men in full equipment.

It is at first surprising that rectal temperature proved an insensitive index of difference between equipments. Differences in rectal temperature between loads of 18 and 48 lb. were negligible and not significant. This again agrees with the finding of Daniels *et al.* (6) for loads of 0 to 61 lb. When, however, the total load (including the man's own weight and clothing) in battle order is considered, the difference between 18 and 48 lb. becomes a mere 15 per cent. of the total load. In the field trials, the order of correlation between pulse rate and rectal temperature was low, with a coefficient of 0.22 (not significant). Data from the laboratory treadmill experiment gave a higher figure ( $r=0.52$ ,  $P<1\%$ ) and other unpublished laboratory data gave a similar coefficient ( $r=0.59$ ,  $P<0.1\%$ ). Such differences in correlation may perhaps be related to the circumstances associated with marching in the open or walking on a laboratory treadmill. Caution should be used in extrapolating laboratory findings into the realities of the field. (2)

The early classic work of Zunz and Schumburg and Brezina and Kolmer, and the more recent studies of Cathcart *et al.*, stressed the value of energy expenditure measurement as the index of the relative efficiency of various forms of load carriage (2). However, such measurement throws light on one aspect of physiological strain, and may give little indication of delayed strains on blood vessels, nerves, ligamentous structure and bone (2). Using ventilation volume as an index of energy expenditure, the present results show that in the laboratory the

maximum difference between equipments is of the order of 5 per cent., and such difference is significant only at the 10 per cent. probability level. Daniels *et al.* (6) found but small differences in metabolic rate between carrying the same load high or low on the back. It has been suggested that pulse rate or rectal temperature may, under certain conditions, be a useful index of metabolism, but our data do not show correlations of a high order between these varieties. Thus for ventilation volume and pulse rate,  $r=0.26$  (not significant); and for ventilation volume and rectal temperature,  $r=0.57$ ,  $P<0.1\%$ .

Subjective data largely confirmed the objective findings. At the end of the trials the order of ranking of equipments showed highly significant agreement between men. The Z2 equipment was given first place and the jerkin was ranked second. In both of these equipments, distribution of load is good from front to back and from side to side, and both are more stable in the rough-and-tumble of field activity than the others. Men stressed the feeling of oneness with the Z2 and jerkin, and that they could jump and crawl with confidence. After the twenty-eight-hour exercises, stability of load and free leg action again emerged as a major consideration of a good equipment. In the repeat preference questionnaire, the rank order of equipments remained the same, but two men changed the first choice. Previous work in this and other laboratories has shown that men are liable to reverse their opinion concerning the value of clothing or equipment.

None of the three performance tests showed significant differences between equipments, although the sand-shovelling test was able to differentiate between loads of 18 and 48 lb. It was noted that whereas the rifle fire accuracy fell off with exertion (results not appended), the performance with the Bren magazine and sand shovelling improved. It has long been known that fatigue may be associated with a decrement in performance only when exhaustion is approaching. In the case of a group of men, motivation and group attitude may alter whilst working together. At the end of a work period, the realization that rest and food are in sight may give a boost to performance. Muscular fatigue is highly specific, and the muscle groups used in a performance test may be far less fatigued than those concerned with locomotion. These are some of the factors which may in part explain the improvement in performance with work. There are pitfalls associated with the use of performance tests, and one should search for a valid test that can be undertaken with the stressful situation and which will escape the criticism open to an interpolated task.

Evidence is accumulating that measurements taken under conditions of rest may not be of particular value in assessing the effect of work. Mahadeva *et al.* (7) show that this appears true for measurements of energy expenditure. Examination of our tables shows that for pulse rate and rectal temperature, the standard errors for "difference" readings (post-work minus pre-work) are larger than for final readings. Analysis of data (not appended) from the performance tests shows a similar finding. Further examination of the data for these variates also shows a larger F ratio for final than for "difference" readings. The cause of such findings is undoubtedly the inherent variability of the resting man. Other possible factors have been mentioned above.

The technique of variance analysis enabled the separation of man-to-man differences in the various objective tests; and our data show significant differences for pulse rate, rectal temperature, ventilation volume and the three performance tests. Men are unique individuals in their physiological and psychological reactions and in their response to work stress. It will hence be surprising if one type of load or load-carriage equipment is ideally suited to all men. The goal for the designer is that equipment suitable for the majority, adaptable to the requirements of the soldier and to the changeable stresses of the field. For the physiologist, however, the hope lies in reduction of the load to be carried.

#### RESUME

Small differences only were found in physiological strain due to the four types of equipment loaded for battle order, but the pulse rate showed differences which were significant.

On the whole, the Z2 Experimental equipment is the best, but it appears that an equipment suitable for one type of work activity may be less suited for another.

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# TREATMENT OF VIVAX MALARIA BY PYRIMETHAMINE (DARAPRIM) AND QUININE

BY

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and

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SIR GORDON COVELL and his colleagues wrote in 1953 : "It is clear that pyrimethamine unaided is not a satisfactory drug for the treatment of vivax malaria in a non-immune subject." The two main reasons for this conclusion were the slowness of clinical response, and the high relapse rate.

For the past year at Tidworth Military Hospital we have treated and followed up 53 service men suffering from vivax malaria. Because of the disappointing results with pyrimethamine alone, we have been using a combination of the drug with quinine. In this paper we give our results to date. The following régime has been observed :

As soon as the diagnosis of vivax malaria has been confirmed by positive blood film, pyrimethamine 10 mg. and quinine 0.6 g. is given orally at twelve-hourly intervals for three doses. The patient is then discharged from hospital, and at his unit receives pyrimethamine 25 mg. weekly for eight consecutive weeks. At the end of this period the unit medical officer returns a follow-up card to the hospital, where it is filed. In this way control is exercised and future follow-up made possible.

Since May, 1953, we have been able to follow 53 of our patients who have been out of hospital for periods varying from six months to one year. Of these, 50 had taken paludrine (proguanil), 1 had taken mepacrine, and 2 had taken virtually no regular prophylactic. In all, 43 (81.1 per cent.) had the primary attack suppressed.

Of the patients, 38 had served in Korea, 9 in Malaya, 2 in West Africa, 3 in Hong Kong, Japan and Korea, and 1 in Jordan. All 53 men were acutely ill in the attack, rigors, headache and abdominal pain being the commonest presenting symptoms. Most cases gave a clear-cut history, but some of the Korean cases relapsed late, and in a minor epidemic of influenza presented a diagnostic problem. It is now our practice to examine the blood for parasites in all pyrexial patients who have served in malarial areas at all recently.

Eleven (21.1 per cent.) of the cases had palpable spleens.

**Results.**—The clinical response to the combined therapy was good, most cases becoming afebrile within twenty-four hours and all in seventy-two hours. Two patients, however, relapsed whilst in hospital and under treatment. These

and all subsequent relapses were treated with pamaquin 10 mg. and quinine 0.6 g. t.d.s. for fourteen days in hospital.

In all 14 patients (26.2 per cent.) relapsed, their average time after completing the course being ninety days.

*Toxic Effects.*—In the doses exhibited we did not encounter any toxic effects attributable to pyrimethamine or quinine.

#### DISCUSSION

Singh *et al.* (1953) treated 30 cases of vivax malaria with pyrimethamine in 25 mg. single doses. They reported that all cases became afebrile after seventy-two hours, but there was no follow-up. Covell (1953) tried pyrimethamine on 12 patients infected with the Madagascar strain of *P. vivax*, but the slow clinical response and high relapse rate proved disappointing. In this series a total of 250 mg. of pyrimethamine was given in five doses of 50 mg. over five days. One-third of these patients relapsed between the 55th and 99th day. There was no indication that an eight-week course of the drug, given weekly, exerted any effect on the relapse rate.

The drug was thought to have an effect on either the pre-erythrocytic or exo-erythrocytic stages of *P. vivax*, and it was hoped that because of the latter, late relapses might be inhibited. As this was not shown in Covell's series it is reasonable to suppose that the exo-erythrocytic forms of the parasite survived the dose of pyrimethamine exhibited. It was for these reasons that in the present series, pyrimethamine has been combined with quinine.

Results have been good as far as the acute attack is concerned. Patients prefer a hospital stay of three days to that incurred by treatment with pamaquin and quinine. The relapse rate, however, has been high, and compared unfavourably with that obtained on using the latter drugs for fourteen-day courses.

#### SUMMARY

1. Fifty-three Service men have been treated for vivax malaria in the past year, using pyrimethamine and quinine. Of these, 26.2 per cent. have relapsed, on an average ninety days after treatment, although the immediate response was good.

2. No toxic effects of the drugs were met.

3. The reasons for combining the drugs are discussed.

4. Pyrimethamine and quinine in these doses is not the treatment of choice for cases of vivax malaria.

We would like to thank Major-General W. R. D. Hamilton, C.B., O.B.E., at whose suggestion this work was undertaken, for his encouragement, and also we acknowledge the co-operation of many unit medical officers in Salisbury Plain District.

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## MANTOUX AND HEAF TUBERCULIN TESTS

A COMPARATIVE TRIAL CARRIED OUT IN THE DEPOT AND TRAINING ESTABLISHMENT, R.A.M.C., JULY-SEPTEMBER, 1954

BY

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THE object of this trial was to determine the advantages, if any, of the Heaf tuberculin test over the Mantoux tuberculin test when performed on a large scale. In this Depot every recruit is tuberculin-tested to decide his suitability for nursing duties in contact with possibly tuberculous patients, and in the case of certain groups—regular soldiers, radiographers, laboratory technicians and operating theatre technicians—as an indication for B.C.G. vaccination. The average age group dealt with was 18-21 years. Each man had recently had a routine chest radiograph.

### *Heaf Tuberculin Test (Heaf, F., 1951)*

*Technique.*—Standardized Old Tuberculin (undiluted) is “adrenalized” by adding 0.1 ml. of a 1 : 100 solution of adrenaline to 1 ml. of undiluted Old Tuberculin. A small drop of the Old Tuberculin is placed on the sterilized flexor surface of the forearm clear of superficial veins, by means of a platinum loop sterilized by flaming.

The Multiple Puncture Apparatus, which enables six punctures to be made of equal depth (2 mm. for adults, 1 mm. for children, depending on which of the detachable endpieces is used), is sterilized by dipping the endpiece in a Petri dish containing a small quantity of spirit and passing it through a flame. When the apparatus has cooled down (about 20-30 seconds), the endpiece is pressed firmly on to the skin where the Old Tuberculin has been placed, and the six needles released by the spring action. This is a painless process.

1 ml. of “adrenalized” Old Tuberculin is sufficient for approximately 200 men.

*Readings.*—Negative : Six faint marks on the skin with no induration.

Positive : Grade I : four or more indurated papules which can be felt, each

measuring at least 1 mm. in diameter. Grade II : the papules have coalesced to form a ring, with normal skin in the middle. Grade III : a plateau of simple induration of any diameter. Grade IV : an area of induration on which blistering or ulceration is superadded.

Erythema is present on the third day in all cases of II, III and IV and most cases of I, but by the seventh day only induration may be present.

### *Mantoux Tuberculin Test*

0.1 ml. of 1 : 1,000 Old Tuberculin is injected intradermally into the sterilized skin of the flexor surface of the forearm so as to raise a wheal of at least 5 mm. diameter. A positive result gives an area of induration of not less than 6 mm. diameter when read on the third day. Simple erythema is not regarded as a positive reaction.

Purified Protein Derivative (P.P.D.) may be substituted for Old Tuberculin in either test, in which case the P.P.D. need not be "adrenalized" in the Heaf test.

### HEAF—MANTOUX COMPARATIVE TRIAL

#### *Method*

Each subject received a Heaf test in the left arm and a Mantoux test using 1 : 10,000 Old Tuberculin in the right arm. Three days later the Heaf results were read with the right arm concealed. Then the Mantoux results were read with the left arm concealed. Those subjects who gave a reaction of 0-2 mm. induration with the Mantoux test were retested with 1 : 100 Old Tuberculin, and those who gave a reaction of 3-5 mm. induration with 1 : 1,000 Old Tuberculin. The Heaf results were read again four days later (the seventh day after Heaf testing), as were the results of the 1 : 100 and 1 : 1,000 Mantoux tests.

#### *Results*

Total number of men tested (Mantoux and Heaf) : 640.

MANTOUX				HEAF	
Positive				Positive, third day	Positive, seventh day
1 : 10,000	...	...	130	129 (99.23%)	128 (98.46%)
1 : 1,000	...	...	59	59 (100%)	59 (100%)
1 : 100	...	...	178	157 (88.20%)	169 (94.94%)
Totals	...	...	367	345	356
Negative				Positive, third day	Positive, seventh day
1 : 1,000	...	...	3	2	2
1 : 100	...	...	270	8	12
Totals	...	...	273	10 (3.66%)	14 (5.13%)
Totals	...	...	640	355 (a) (55.47%)	370 (b) (57.81%)

(a) Heaf-positive on third day, Heaf-negative on seventh day ... .. 7 (1.86%)

(b) Heaf-negative on third day, Heaf-positive on seventh day ... .. 22 (5.83%)

Total Heaf-positive (on one or both days) ... .. 377 (58.9%)

## DISCUSSION

Before attempting to draw conclusions from the above results, it is necessary to point out two possible sources of error. First, measurements of the diameter of induration in the Mantoux tests were made with a ruler as calipers were not available. Secondly, there were 22 (5.83 per cent.) instances where the Heaf readings were negative on the third day but had become positive by the seventh day. All these had received 1:100 Tuberculin on the third day, and it has been suggested that this injection had "potentiated" the Heaf test to make it positive by the seventh day.

In an effort to resolve this latter problem, 304 men were Heaf tested and received no Mantoux test. This survey gave the following results :

Total number of men tested	...	...	...	...	...	304
Heaf-positive on one or both days	...	...	...	...	...	161 (52.96%)
Heaf-positive on third day	...	...	...	...	...	151 (49.67%)
Heaf-positive on seventh day	...	...	...	...	...	158 (51.97%)
Heaf-negative on third day, Heaf-positive on seventh day	...	...	...	...	...	10 (6.21%)
Heaf-positive on third day, Heaf-negative on seventh day	...	...	...	...	...	3 (1.86%)

These figures follow closely those obtained in the main trial, and despite the small number investigated they do suggest that there is in fact no potentiation of the Heaf test when a second Mantoux test is performed on the third day. It is inferred from these facts that the third day is too early to read the Heaf test and that the fifth or sixth day would be better.

It is to be expected that those men who are Mantoux-positive to the higher dilutions of tuberculin (1:10,000 and 1:1,000) will give a high percentage of Heaf-positive readings on both third and seventh days, since their tuberculin sensitivity is high. This is borne out by the results.

The percentage of Heaf-positives amongst those who required 1:100 tuberculin to reveal sensitivity was appreciably lower, being 88.2 per cent. on the third day and 94.94 per cent. on the seventh. The higher percentage of Heaf-positives on the seventh day has already been discussed.

The percentages of total Mantoux- and Heaf-positives (57.34 per cent. and 58.9 per cent.) are very similar, but both figures are much lower than the 85 per cent. usually quoted for the population as a whole. This is no doubt due to the age group involved, chiefly 18 to 21 years.

## ADVANTAGES OF THE HEAF TEST

1. *Speed*.—If two instruments are available and used alternately, one being allowed to cool after sterilization while the other is in use,\* 200 tests can be performed in an hour by one operator. The same number of Heaf readings can be done in a much shorter time, depending on the supply of clerks to write down the results.

2. *Simplicity*.—If the quantity of tuberculin is sufficient, and if the apparatus is placed firmly and squarely on the forearm, the performance of the test is uniform and foolproof. No skill is required.

3. *Painlessness*.—The Heaf test is painless.



4. *Accurate and Easy Readings.*—As soon as one is familiar with the Heaf-positive Grade I results, the readings are more easily and speedily performed than Mantoux readings. The reading of Grades II, III and IV is especially simple.

5. *Lack of Severe Reactions.*—A small number of men with Grade IV readings complained of slight discomfort which cleared up quickly with Anthisan cream. It must be stated, however, that painful arms following Mantoux testing has been equally uncommon in this unit.

#### SUMMARY

1. The Mantoux and Heaf tuberculin tests have been compared in 640 men.
2. The results of the Heaf tests closely follow those of the Mantoux tests, and therefore the Heaf test may be substituted for the Mantoux.
3. It is suggested that the fifth or sixth day would be more suitable for reading the Heaf test than the third day.
4. The Heaf test is simple and the results are easily read.
5. The Heaf test is painless and reactions are negligible.

We are indebted to Dr. K. Neville Irvine, M.A., D.M., B.Ch. (Oxon.), Adviser on B.C.G. Vaccination to the Oxford Regional Hospital Board, for advice and guidance in this trial.

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## *Editorial*

### SIR DAVID BRUCE 1855-1931

EXPLANATION, but not apology, seems necessary for offering a portrait of Sir David Bruce, in this his centenary number, in plain clothes rather than in uniform. Technical considerations apart, two reasons may be given : first, the photographs of Sir David and Lady Bruce are a pair, and second, they have been generously lent by Professor A. D. Peacock, of St. Andrews University. It has not been easy to obtain contributions from those who worked with Bruce, for many of his contemporaries are, understandably, advancing in years and failing in health. Dr. Muriel Robertson and Professor Tulloch, whom it is a pleasure to welcome back as a contributor to the JOURNAL after a lapse of over twenty-five years, are brilliant exceptions, and we may congratulate Professor Peacock upon the reason, pressure of other work, which prevents him from doing more than pay us the compliment of lending his treasured photographs for reproduction.

"Bruce always laid stress on the great services his wife rendered him, and, when he lay on his death-bed, he very definitely expressed the wish that any notice of his scientific work which might be made should include a statement of how much he had been indebted to her in the prosecution of all his work."\* The basic facts of Bruce's life, which read more like fiction than fact, are well known : Mary Bruce's part is less so. Once married, they were never apart. Bruce entered the service in 1883 already married, and thereafter, at home or abroad, in the laboratory or in the field, in besieged Ladysmith and in tropical Africa, David and Mary Bruce went together : "wherefore they are no more twain, but one flesh." She worked with him in his first investigation, of a cholera epidemic in Malta, an undertaking not devoid of risk, as the causative organism was not isolated until two years later. Their leave after Bruce's discovery of the *Micrococcus melitensis* was spent together in Koch's laboratory in Berlin. No matter what the task, the combination of Bruce's ability as a field naturalist (it had been his outstanding marks in natural history which gained him first place in the competitive examination for entry to the Army Medical School) with his wife's artistic talents, expressed in nice laboratory technique, formed the ideal basis for the routine of observation, experiment and deduction upon which all Bruce's work was founded.

Loyalty was one of Bruce's most strongly developed characteristics. Even though much of his service was spent in special investigations and seconded employment, every move was accepted as a matter of duty. There was never demur if a task had to be left unfinished when he was required to devote his

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\* *Obituary Notices of Fellows of the Royal Society*, No. 1, 1932, pp. 79-85.

attention to another. Facts were ascertained and recorded : deductions were drawn and published : at every stage, as Bruce was called to some other work, his findings were available for others to take up and extend as occasion offered. Facts and methods were distinguished by such thoroughness and accuracy as to be virtually beyond challenge : his deductions, inevitably, were not always so. This scientific honesty, the painstaking craftsmanship, and the error which arises when speculation is substituted for deduction, are well shown in Bruce's first two papers on Malta fever.\* In 1904 Bruce became chairman of the Malta Fever Commission which finally elucidated the ætiology of Malta fever, so that, although he did not personally perform the actual experiments which at last solved the problem and led to a reduction of the number of service cases of this disease in Malta from 913 in 1905 to 11 in 1908, and to 4 in 1910, it was under his direction that the work was done which set the seal upon his own pioneer researches of twenty years earlier.

Meanwhile sleeping sickness had claimed his attention. In 1894, after five years at Netley as assistant professor of pathology, first under Aitken and later under Wright, Bruce went to South Africa. It so happened that Sir Walter Hely-Hutchinson, the Lieutenant-Governor of Natal, had been in Malta when Bruce had carried out his earlier researches there, and he asked for Bruce's services in investigating nagana. By the following year, Bruce had demonstrated that a trypanosome, *T. brucei*, was the causative organism and, even more important, he had shown for the first time the role of insects as vectors. Bruce then returned to military duty. He was present at the engagements at Elands-laagte and Laing's Nek, and in Ladysmith during the siege as officer commanding No. 1 Stationary Hospital, in which he acted as surgeon, with Mrs. Bruce as his theatre sister and assistant. (Lieutenant and Quartermaster F. Bruce, radiographer in Ladysmith during the siege, describes him as "the chief operating surgeon.")

After the relief of Ladysmith, Bruce was appointed, with Colonel J. L. Notter, Professor of Military Hygiene at Netley, and Professor (afterwards Sir) William J. R. Simpson, Professor of Hygiene in King's College, London, to a commission which studied the origins of dysentery in the field and its relation to enteric fever. A report was presented to Parliament in 1902, but it failed to add to knowledge of the subject.

In 1903 Bruce returned to the study of trypanosomiasis with the Sleeping Sickness Commission, this time in Uganda, and within a few months obtained conclusive evidence of its trypanosomal ætiology and of its spread by *Glossina palpalis*. He went back to Uganda from 1908 to 1910, and to Nyasaland from 1911 to 1914. This was the end of his work as a field naturalist. Between the two periods in Uganda, from 1904 to 1908, Bruce edited this Journal.

On returning to England in November, 1914, Bruce was appointed Commandant of the R.A.M. College, but he was unable to regard this as purely an administrative appointment. He continued his scientific work as a member of

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\* *Practitioner* (1887), 39, 161-170 ; and *Practitioner* (1888), 40, 241-249.

the Trench Fever Committee, and in investigations of tetanus in military hospitals at home. This work continued until his retirement in 1919, after which he became Chairman of the Lister Institute.

Bruce's modesty and reserved manner have left him few memorials. His *Micrococcus melitensis* has, since 1920, been included with other related organisms in the genus *Brucella*, and *Trypanosoma brucei* commemorates his contributions to the study of sleeping sickness, but eponymity can be as concealing as anonymity. He is one of the masters and founders of tropical medicine whose names are built into the fabric of the London School of Hygiene and Tropical Medicine. In the Army, the David Bruce Military Hospital in Malta recalls his early work there, and the David Bruce Laboratories, as the Army Vaccine Laboratory was renamed in January, 1951, trace their descent from the Army Medical School in which Bruce served as probationer and assistant professor, through the R.A.M. College which he commanded. The Royal Army Medical Corps will not forget the first of its officers to be elected a Fellow of the Royal Society.

Only the most senior serving officers can have known Bruce in the Army: even those who met or saw him are a diminishing band. To the military medical officer of today, Bruce is known by his portrait, of an imposing and perhaps forbidding figure, in the Headquarter Mess and by the case containing his decorations and prize medals, which he gave to the Corps "as an inspiration to those who come after me." There are those who have found this collection—thirteen prize medals, the insignia of a military K.C.B., civil C.B. and knight bachelor, and others—inspire sentiments exactly opposite to those which Sir David intended and which had inspired him. They may recall that "in the public service, the reward of hard work is more work," and that Bruce was in every way handsomely rewarded.

It was work, not honours, that Bruce sought. His work was productive of something more durable than honours, and it is in loyalty to Bruce's last expressed wish that we join Lady Bruce with him in paying this centenary tribute to it. It would be a fitting epilogue if authority could be found for the suggestion that it was to Lady Bruce's cousin, General Sir Walter Bedford, that the Corps is indebted for its badge and for the motto, so appropriate to the Bruces,

IN ARDUIS FIDELIS

## *Matters of Interest*

### NOTICE TO AUTHORS

A ruling has lately been given by the War Office that Queen's Regulations, 1940, paragraph 547, is to be strictly observed. In particular, the attention of serving officers, and others whose contributions are governed by this regulation, is invited to lines 14-17 of sub-paragraph (c), which forbid acknowledgment of permission to publish. Acknowledgment of professional and other assistance is, of course, still allowed.

#### PAPERS BY R.A.M.C. OFFICERS

Lieut.-Colonel K. P. Brown : Epidemic Hæmorrhagic Fever. *Trans. Roy. Soc. Trop. Med. Hyg.* (1954), **48**, 105-111.

Colonel L. W. Harrison : Ehrlich *versus* Syphilis. *Brit. J. Vener. Dis.* (1954), **30**, 2-6.

Lieut.-Colonel J. Mackay-Dick : Penicillin in the Treatment of Diphtheria (letter). *Lancet* (1954), **2**, 559.

### ANNUAL MEETING OF THE BRITISH MEDICAL ASSOCIATION, GLASGOW, 5TH-9TH JULY, 1954

The Royal Army Medical College contributed a demonstration on mite-borne typhus to the Scientific Exhibition of the B.M.A. at Glasgow. The quality showed no falling off from that of the previous exhibits on malaria and enteric fever, but the subject was not so fortunately chosen ; at Glasgow, interest in a tropical disease with a distribution restricted to the Far East was limited.

Of the Service exhibits, that shown by the Royal Navy on survival at sea attracted most interest.

The comment of the *British Medical Journal* on the College exhibit was that "The Royal Army Medical Corps, however, presented a clinical subject, giving a comprehensive account of mite-borne (scrub) typhus." It is, perhaps, a fair criticism that the account was too comprehensive and that the exhibit would have benefited from cutting of the script.

### BERTRAND STEWART PRIZE ESSAY COMPETITION, 1955

#### 1. The subject of this year's competition is as follows :

There has of recent years been increasing difficulty in finding men of the right quality who are prepared to take up a career in the Regular forces, including candidates for commissions. It is, moreover, doubtful whether improved emoluments and conditions of service will of themselves overcome this difficulty. Discuss the reasons for this state of affairs and suggest what could be done to solve the problem both inside and outside the Services.

#### 2. The result of last year's competition was as follows :

Winner : Lieut.-Colonel A. D. R. G. Wilson, M.B.E., A. and S.H.

Runner-up : Lieut.-Colonel P. M. Bennett, R.E.

3. The rules for the 1955 Competition were given in the July, 1954, and October, 1954, editions of *The Army Quarterly*.



# HISTORY

## PREVENTION

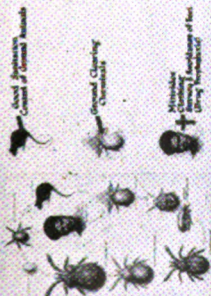
## GENERAL

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## PREVENTION



First pass on sound footing by Australians and American doctors who obtained value of double-breasted suiters with underides. 20-belt pleats (17.1 E) total hand-drawn construction in 1911

## METHODS

1. *Grassroots movement (GSM)*  
 2. *People's movement (PM)*  
 3. *People's movement (PM)*  
 4. *People's movement (PM)*

- **Global** = all-around, broad area
- **Local** = immediate area, within walking distance
- **Regional** = within a certain area
- **State** = a government within a country



1

## INDIVIDUAL

There is a growing body of evidence suggesting that the use of a structured approach to research can improve the quality of research. This approach involves the use of a research protocol, which is a document that outlines the objectives, methods, and procedures of a study. The use of a research protocol can help to ensure that the study is conducted in a systematic and consistent manner, and that the results are reliable and valid.



(Continued from page 10)  
 and the other two  
 authors are  
 currently at the  
 University of  
 California, San  
 Diego.

## GENERAL

When asked by participants for  
additional advice, she responded by  
saying, "I'd suggest that you  
start out with a very small group  
and just have a few meetings and  
see if it works for you. If it doesn't,  
you can always stop it. It's not  
like you're going to be in it for  
the rest of your life."



1

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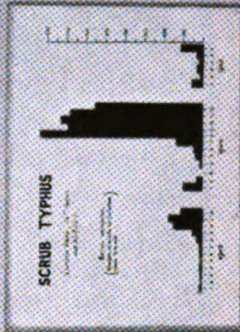


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SIDE PANEL, GLASGOW EXHIBIT

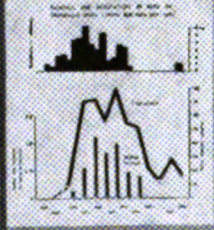


# EPIDEMIOLOGY

## CAUSE

1. **Vector** - *Dermacentor variator*  
 2. **Host** - Human  
 3. **Environment** - Warm, humid, and shaded areas  
 4. **Season** - Spring and summer  
 5. **Location** - Rural and suburban areas  
 6. **Prevalence** - 10-20% in rural areas  
 7. **Incidence** - 1-2% in urban areas  
 8. **Duration** - 1-2 weeks  
 9. **Complications** - Anemia, allergic reactions, and secondary infections

## MITE TYPES - INCIDENCE



## SEASONAL INCIDENCE

1. **Spring** - High incidence  
 2. **Summer** - High incidence  
 3. **Fall** - Low incidence  
 4. **Winter** - Low incidence

## TRANSMISSION

### VECTOR

1. **Vector** - *Dermacentor variator*  
 2. **Host** - Human  
 3. **Environment** - Warm, humid, and shaded areas  
 4. **Season** - Spring and summer  
 5. **Location** - Rural and suburban areas  
 6. **Prevalence** - 10-20% in rural areas  
 7. **Incidence** - 1-2% in urban areas  
 8. **Duration** - 1-2 weeks  
 9. **Complications** - Anemia, allergic reactions, and secondary infections

## HOSTS OF MITE

1. **Human**  
 2. **Dog**  
 3. **Cat**  
 4. **Mouse**  
 5. **Rat**  
 6. **Deer**  
 7. **Wild birds**  
 8. **Wild mammals**  
 9. **Wild reptiles**  
 10. **Wild amphibians**  
 11. **Wild fish**  
 12. **Wild invertebrates**



Deer - 1929



Bird - 1929



## MITE-BORN LIFE CYCLE

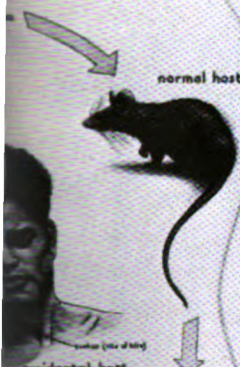




*Peritetrastia orientalis*)  
THE MITE

parasitic larva (unfed)

normal host



accidental host

parasitic larva (engorged)

quiescent  
nympha-chrysalis



## EPIDEMIOLOGY

### GENERAL DISTRIBUTION

Found in all parts of the world, but especially in the tropics and subtropics. It is found in all parts of the world, but especially in the tropics and subtropics. It is found in all parts of the world, but especially in the tropics and subtropics.



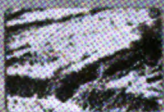
### LOCAL DISTRIBUTION

Found in all parts of the world, but especially in the tropics and subtropics. It is found in all parts of the world, but especially in the tropics and subtropics. It is found in all parts of the world, but especially in the tropics and subtropics.

### DISTRIBUTION



#### FOREST FRINGE



#### MOIST AREAS



#### TEMPLES

Found in all parts of the world, but especially in the tropics and subtropics. It is found in all parts of the world, but especially in the tropics and subtropics. It is found in all parts of the world, but especially in the tropics and subtropics.

#### WASTE LANDS



#### NEGLECTED CAMP SITES

Location	Number of mites found
Forest fringe	10
Moist areas	20
Temples	30
Waste lands	40
Neglected camp sites	50

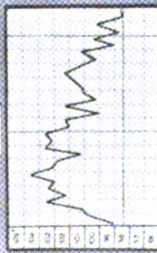




# CLINICAL

STANDARD CURVE FOR TYPHOID FEVER  
 (TEMPERATURE IN °C)  
 (TEMPERATURE IN °F)  
 (TEMPERATURE IN °C)  
 (TEMPERATURE IN °F)

## FEVER



ECZEMA  
 (TEMPERATURE IN °C)  
 (TEMPERATURE IN °F)



RAHE  
 (TEMPERATURE IN °C)  
 (TEMPERATURE IN °F)



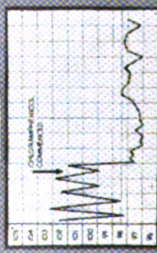
ACUTE SYSTEM  
 (TEMPERATURE IN °C)  
 (TEMPERATURE IN °F)

CHRONIC SYSTEM  
 (TEMPERATURE IN °C)  
 (TEMPERATURE IN °F)

RESPIRATORY SYSTEM  
 (TEMPERATURE IN °C)  
 (TEMPERATURE IN °F)

DIFFERENTIAL DIAGNOSIS  
 (TEMPERATURE IN °C)  
 (TEMPERATURE IN °F)

## THE TREATMENT



CONCLUSION: The treatment of typhoid fever is a long and difficult task. The patient must be kept in bed and given plenty of rest. The diet should be light and easily digestible. The patient should be given plenty of fluids. The treatment should be continued for at least two weeks.

# LABORATORY

STANDARD CURVE FOR TYPHOID FEVER  
 (TEMPERATURE IN °C)  
 (TEMPERATURE IN °F)  
 (TEMPERATURE IN °C)  
 (TEMPERATURE IN °F)

## WEIL FELIX TEST



The Weil-Felix test is a test for typhoid fever. It is based on the agglutination of typhoid bacilli with the serum of a patient with typhoid fever. The test is performed by mixing a small amount of the patient's serum with a small amount of typhoid bacilli. If the serum contains antibodies against the bacilli, they will agglutinate.

## ISOLATION



THE ISOLATED BACILLI



THE TYPICAL CASE



THE ISOLATED BACILLI

The isolation of typhoid bacilli is a difficult task. It requires the use of special media and techniques. The isolation is usually performed by inoculating a sample of the patient's stool or urine into a special medium. The medium is then incubated at 37°C for 48 hours. If the sample contains typhoid bacilli, they will grow in the medium.



CULTURE IN THE LABORATORY



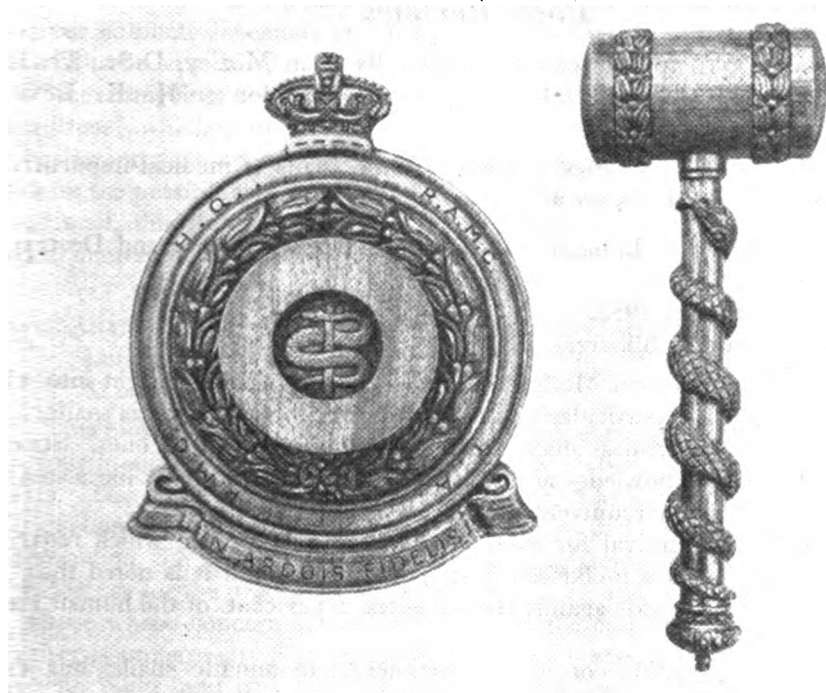
## SEROLOGY

### COMPLEMENT FIXATION TEST

The complement fixation test is a test for typhoid fever. It is based on the reaction between the serum of a patient with typhoid fever and the complement of a typhoid bacillus. The test is performed by mixing a small amount of the patient's serum with a small amount of typhoid bacilli. If the serum contains antibodies against the bacilli, they will fix the complement, and the test will be positive.

### NEUTRALISATION TESTS

The neutralisation test is a test for typhoid fever. It is based on the reaction between the serum of a patient with typhoid fever and the complement of a typhoid bacillus. The test is performed by mixing a small amount of the patient's serum with a small amount of typhoid bacilli. If the serum contains antibodies against the bacilli, they will neutralise the complement, and the test will be positive.



GAVEL AND BLOCK, MEDICAL UNITS, 42ND (LANCS) INFANTRY DIVISION, T.A.

#### 42ND (LANCASHIRE) INFANTRY DIVISION R.A.M.C. (T.A.)

The illustration shows the handsome gavel and block which have been presented to the medical units of 42nd (Lancs) Infantry Division, T.A., by a serving officer who wishes to remain anonymous. Both block and gavel are of walnut, and they live and travel to camp in a box with a "Perspex" front.

The block has a raised annulus round the serpent to prevent it from being flattened, and the gavel incorporates all the elements of the Corps' badge.

R. G. W. OLLERENSHAW,  
Colonel, A.D.M.S.

#### THE ARMY MEDICAL CORPS JOURNAL (INDIA)

*The Army Medical Corps Journal* is the publication of the Armed Forces Medical Services in India and is issued quarterly in January, April, July and October. It contains useful information on health problems in the services and is therefore invaluable to all Commanding Officers who are interested in the health and physical fitness of all ranks under their command.

The annual subscription is Rs6 only (9s.). Copies can be had from the Manager, *A.M.C. Journal*, A.M.C. Centre (South), Poona-1, India.

## Book Reviews

AN INTRODUCTION TO MOLLUSCAN ECOLOGY. By Alan Mozley, D.Sc., Ph.D., F.R.S.E. Pp. x + 72. 15 illustrations. London: H. K. Lewis. 1954. 9s.

This is the fourth of a series of handbooks on snails of medical importance by Dr. Mozley. The others are as follows :

1. Snail Hosts of Bilharzia in Africa—Their Occurrence and Destruction, 1951.
2. Molluscicides, 1952.
3. Prevention of Bilharzia, 1953.

This small handbook on Molluscan Ecology gives valuable insight into the way of life of snails and particularly into the requirements of Bilharzia snails.

It points out that harmless snails greatly outnumber dangerous ones. Stress is laid on the need for knowledge and insight, or the ability to "think like a snail" in order successfully to circumvent the disease-bearing kinds.

The problem of survival for such parasites as *Schistosoma*, which require both a mammalian and a molluscan host, is examined, and it is noted that in spite of the theoretical odds against the parasites, 5 per cent. of the human race is still infected.

Tree-shade is generally considered detrimental to aquatic snails, but not that of willow trees, as their leaves give good feeding. Desert wells are considered safe, as Bilharzia snails do not like an underground habitat, but surface storage tanks may become dangerous breeding-places.

One of the most important portions of this handbook explains the term "ecotone"—an area where animals or plants barely survive for perhaps long periods, with, however, the ability to flourish suddenly if circumstances change in their favour. In this way Bilharzia snails just barely survive over large areas of Africa, waiting for improved conditions. Faulty disposal of sewage or new irrigation schemes may suddenly change a survival ecotone to a dangerous snail plague area. On the other hand, the legend that all bodies of fresh water contain Bilharzia snails is untrue. It is usually the water around villages that is particularly infested.

It is considered that much knowledge and experience is needed to interpret correctly the relationship between snails, habitats and disease. For instance, the snails might appear to be much more at home in moist areas than dry ones. However, some semi-arid regions may cause humans to depend on small local areas of water which, with the accumulation of rubbish, may become dangerous foci of Bilharzia, out of all proportion to the amount of water present. The prevention of pollution is thought to be most important in checking dangerous snail multiplication.

Great fluctuations in water depth, say of twenty feet, are stated to be devastating to molluscan life, though water engineers and conservators generally frown on such measures.

Methods for snail surveys are also discussed and control measures reviewed. Copper sulphate in canals and other bodies of water round villages has been proved to be a practical and economical molluscicide.

The foregoing are some abstracts from this interesting and informative handbook, which ends with appendices on the life cycles of two disease parasites, on the nomenclature of snails, on the correct timing of control measures, and on the possible use of radiation.

In all, this publication forms a very readable and useful background for those interested in the study of Bilharzia.

J. H. G.

THE ANATOMY OF THE EYE AND ORBIT. 4th Edition. By Eugene Wolff. London: H. K. Lewis. 1954. Pp. viii+492, 406 illus. (including 52 coloured). 63s.

This most excellent textbook, which first appeared in 1933, has now reached its fourth edition and incorporates much new material and many new illustrations. The production is first class, the text is clear and most readable, and the illustrations are beautifully executed. Giving, as it does, much valuable clinical information, the book is no mere textbook of anatomy, but is a valuable source of reference for the practising physician or surgeon and contains much of interest to those whose concern is not primarily ophthalmology. To praise this book further is unnecessary; it conforms to the high standard to be expected from Eugene Wolff, and it is sad that no more work can come from his pen. This book is an undoubted classic and will long remain an inspiration to the reader and a memorial to its author.

J. B. G.

EXPERT COMMITTEE ON MALARIA. FIFTH REPORT. W.H.O. Tech. Rep. Ser. No. 80. Geneva, 1954. Pp. 42. 1s. 9d.

In a subject which is burdened with conflicting reports, it is refreshing to read an authoritative opinion on the outstanding problems in malaria control. *Resistance of anophelines* to D.D.T. has not been reported from the majority of control schemes, and even where described the resistance has not been adequately measured by laboratory techniques. A simple test within the reach of all laboratory personnel is described for measuring the resistance of mosquitoes to volatile and non-volatile insecticides. While this test in no way simulates natural conditions, it allows for a simple standardization of results from different countries for comparison. The report continues on a reassuring note by stating that the resistance of anophelines is not of the same order as the formidable one developed by houseflies, and constitutes no barrier to continued malaria control by residual insecticides. A useful list of figures, based on world experience, is given for the length of residual periods on absorbent and non-absorbent surfaces of different dosages of D.D.T., B.H.C. and Dieldrin. There is emphasis on the importance of ensuring that wettable powders should comply with the specifications laid down by the Expert Committee on Insecticides. The section on *Chemotherapy* is of particular value, with a concise summary of drugs and



their dosage recommended for the treatment and prophylaxis of malaria. Primaquine is the drug of choice for the radical cure of *P. vivax* and *P. malariae* infections, and it is reported to be more effective and far less toxic than pamaquine. The list of antimalarial drugs with their various synonyms will do much to dispel the existing confusion in nomenclature. Reduction and even cessation of malaria control is advocated in areas in which transmission has virtually ceased following successful schemes, with the proviso that scientific vigilance be maintained indefinitely to give early warning of re-introduction. Finally, it is emphasized that, in spite of the new methods, the old-established measures still have their place in control. The most efficient and economical control will be a combination of methods by a well-planned, preliminary survey.

M. A. C. D.

SYMPOSIUM ON HUMAN FACTORS IN EQUIPMENT DESIGN. Ergonomics Research Society Proceedings, Vol. II. Edited by W. F. Floyd and A. T. Welford. London: H. K. Lewis. 1954. Pp. viii+132. 17 illustrations in plates and text. 21s.

This publication results from a very interesting symposium of the same title held by the Ergonomics Research Society. The contents illustrate clearly the intention of the Society, which was formed in 1950 to bring together those who study man in relation to his working environment in order that both man and machine may function with the utmost efficiency.

Professor Le Gros Clark has indicated the applications of anatomical science to the study of the problems in this field, and has illustrated his points with examples from Service and other sources. His introductory remarks are followed by the detailed studies of Drs. Morant, Clements, Åkerblom and Darcus, in which, respectively, they deal with the dimensions of work-spaces (*e.g.*, a vehicle's driving cabin) in relation to body size, a survey of the bodily measurements of the working population, the "ideal" chair in relation to the general mechanics of sitting, and examples of work undertaken to determine the range and strength of joint movement.

In "Physiological Effects of Climate on Man," Dr. Edholm has outlined methods of measurement of climate, the processes by which body temperature is regulated, and the effects of extremes of heat and cold. The insulation provided by body tissues and clothing (including the *Clo* unit) is discussed briefly but thoroughly, along with the physiological principles governing the use of clothing. The latter were formulated largely as a result of the war-time demands of the Services, whereas changes in industrial working clothes are stated to be of but a trivial nature over the last thirty years. Marius Nielsen and Laurents Pedersen, in an account of experiments on heat loss by radiation and convection, have shown a close relationship between the resultant temperature (a function of air and radiant temperature) and rectal, skin, and clothing temperatures.

In his abstract "Circulatory Insufficiency in the Standing Position," Professor Christensen sets out the most favourable positions for working and

resting. The physiological contributions are completed by the summary of the monograph by Per-Olaf Åstrand, entitled "Experimental Studies of Physical Working Capacity in Relation to Sex and Age," carried out on males and females from ages 4 to 33.

M. D. Vernon and Norah E. Graham discuss the factors influencing the control of complicated dial or similar systems from the psychological standpoint, while the concepts of speed and load as applied to such "displays" are discussed by R. Conrad in his contribution "Speed Stress." In "Movement and Force in Sensori-Motor Skill," C. B. Gibbs has given details of apparatus for the experimental analysis of performance, and the learning and transfer of visuo-motor skill. K. F. H. Murrell completes the volume with his contribution on "Equipment Layout," which sets out examples of the results of not fitting machines to their users, and of the problems associated with the attainment of the ideal user-machine relationship.

This little volume is eminently worth while for those interested in any aspect of the user-machine relationship in industry, and its contributions have approached the problems from the main standpoints of anatomy, physiology, experimental psychology and industrial medicine. Each contribution has a full reference list.

J. L. A.

**FLUID BALANCE IN SURGICAL PRACTICE.** L. P. LeQuesne, M.A., B.M. (Oxon), F.R.C.S., Assistant Director, Department of Surgical Studies, Middlesex Hospital. London: Lloyd-Luke (Medical Books) Ltd. 1954. Pp. viii + 130. 41 figures. 17s. 6d.

I have enjoyed reading this excellent and practical monograph. The physiology is very well summarized and is not difficult to understand. The treatment of electrolytic disorders is described clearly, so that anyone possessing this very useful guide should have no doubts about treating surgical patients suffering from disturbances of fluid metabolism either before or after operation. I have no hesitation in recommending that every surgeon and anæsthetist in the Corps should read and digest the contents of this book.

R. A. S.

**TECHNIQUES IN CLINICAL CHEMISTRY: A HANDBOOK FOR MEDICAL LABORATORY TECHNICIANS.** By Frederick N. Bullock, F.I.M.L.T., F.R.M.S., F.C.S. Bristol: John Wright & Sons Ltd. 1954. Pp. 171. 16s. 6d.

Every biochemist has his own methods of analysis, which he has tested and found to be satisfactory. In this book the author has set forth his own methods very clearly and systematically. Chapters in the book include fundamentals such as the preparation of solutions accurately, preliminary preparation such as the cleaning of glassware, and collection of samples. Then follow chapters on the usual determinations of the constituents of blood, cerebrospinal fluid, fæces and urine, also on gastric analysis and tests of renal and liver function. There is a useful appendix containing various data and finally an index.

There are a few criticisms one can make in a helpful spirit. The first is

that the author does not appear to like photo-electric colorimeters and prefers the visual type. As so many laboratories, at least in the United Kingdom, use photo-electric colorimeters, it would seem essential to describe them. Then, secondly, absorption indicators are widely used, especially in the determination of chlorides in plasma, but the author considers their use "beyond the scope of a book of this size" (p. 24). Also the author uses the tyrosine standard method for the determination of plasma proteins instead of the usual colorimetric Kjeldahl determination. Finally, there is no reference to the Lovibond colorimetric methods widely used, it is understood, all over the world. Of course, inclusion of these items would enlarge the book a little, but it might be worth while.

The printing and binding are satisfactory and in reading it through no mistakes of any importance were found.

S. E.

The following have also been received :

MALAYAN PARASITES, I-XV. By J. R. Audy. Studies from the Institute for Medical Research, Federation of Malaya, No. 26. 1953. 21s.

BIOLOGY OF *Anopheles gambiae* : RESEARCH IN FRENCH WEST AFRICA. By M. H. Holstein. W.H.O. Monograph Series No. 9. 1954. Pp. 172.

"ANY QUESTIONS ?" 3rd Series. London : British Medical Association. 1954. 7s. 6d.

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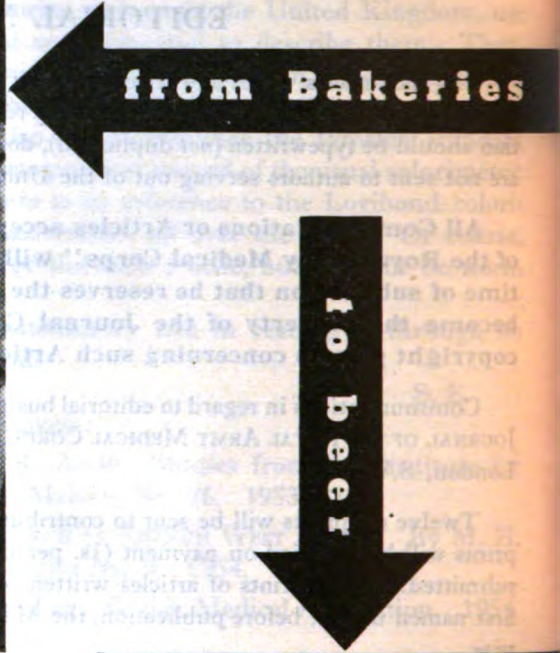
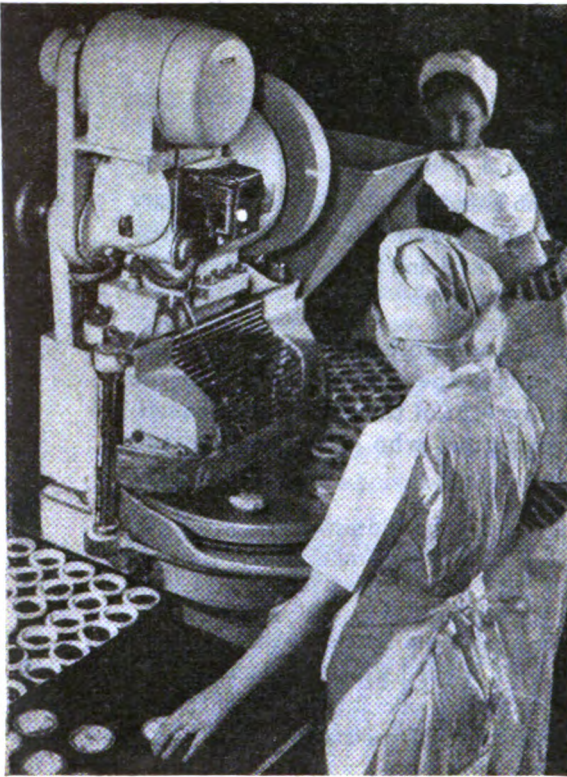
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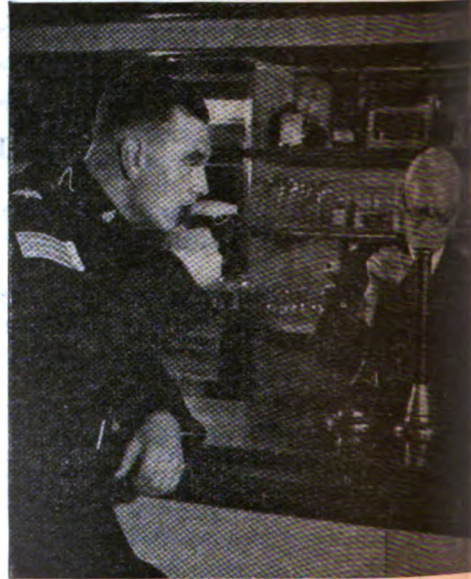


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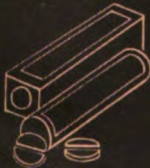
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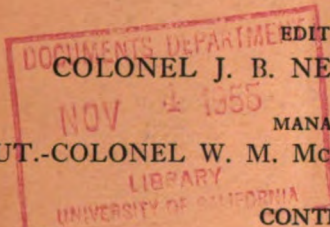


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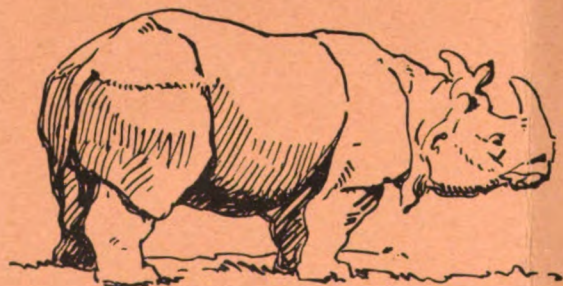
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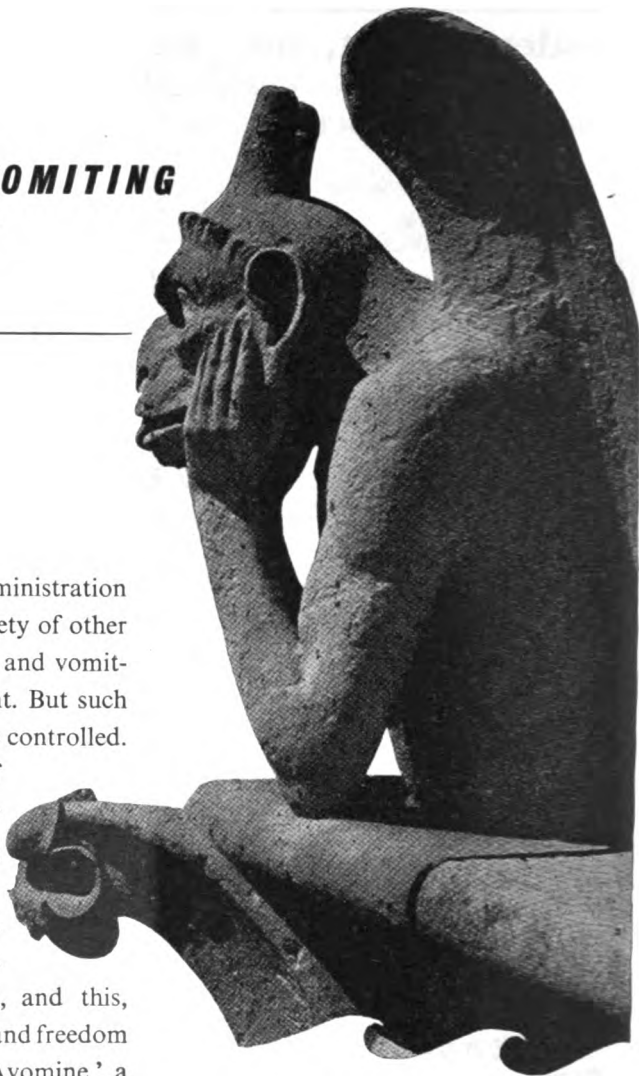
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# Journal of the Royal Army Medical Corps

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## THE EARLY HISTORY OF TYPHOID VACCINATION\*

BY

W. CHAS. COCKBURN, M.B., D.P.H.

*Director, Epidemiological Research Laboratory, Central  
Public Health Laboratory, London, N.W.9.*

WHEN General Hilton-Sergeant asked me to give one of the evening lectures this session, I thought it might be of interest to recall some of the early work on typhoid vaccination. I realize that to many of you it must be more familiar than it is to me, and you may think it presumptuous of an outsider to discuss in this building work which was carried out almost entirely by members of the Army Medical Services. I hope, however, that what I have to say will be as fresh to some of the younger members of the Royal Army Medical Corps as it was to me when, for reasons which some of you will know, I became specially interested in it about a year ago. For the past seven years I have been closely associated with a series of field studies into the value of another bacterial antigen—whooping-cough vaccine—and am perhaps in as good a position as anyone to appreciate the difficulties which had to be overcome, and the amount of effort which went into the field work, in the early studies of typhoid vaccines.

It is convenient to define the early history of typhoid vaccination as that of the period between 1896 and the beginning of the 1914-18 war, and for the purpose of this lecture to confine the story to the work on vaccination done in Britain and in the British Army.

---

\* Based on a lecture given at the Royal Army Medical College on 14th January, 1954.

PREVALENCE OF TYPHOID FEVER IN THE LATTER HALF OF THE  
NINETEENTH CENTURY

It is difficult for us to appreciate now the importance of the enteric fevers in the fifty years before vaccination was introduced, but it is necessary to have some understanding of this and of the increasing interest in the epidemiology of the disease before discussing vaccination. In the civil population in England and Wales in 1870 there were about 500 deaths per million of the population. In 1880 there were about 300 deaths per million, and in 1890 about 200 per million. You will notice that though the rates were very high they were falling before the end of the century and, as you know, the rapidity of the decline increased until in the early 1920's they became negligible. In the armed services during war time and in peace time in foreign stations at the turn of the century the incidence of enteric was far greater than in civil life; in the Spanish-American War of 1898, for instance, one in five of the 100,000 officers and men engaged were recorded as having developed enteric fever, and 1,600 of the recorded cases were fatal. The incidence was probably very much greater than the official figures suggested. When Vaughan (1899) and his colleagues made an investigation they found that, in order to cover up the true position, many of the cases were being diagnosed as other diseases. In one regiment all the deaths were ascribed to dengue, and in another 15 per cent. of the deaths were said to have been due to "indigestion." Yet on making serological examinations Vaughan found evidence of recent enteric infection in almost every case of prolonged pyrexia.

When reading about enteric fever in the second half of the nineteenth century one can see how the emphasis slowly changed from descriptions of methods of treatment to reports on investigations into the sources and modes of spread of infection. After Budd's paper in 1856, reports on water-borne outbreaks began to appear and by the end of the century were frequent. One of the earliest was the description of the outbreak in Lausen in Switzerland in 1872, when about 130 of the 780 inhabitants of the village developed typhoid between August and October. All the cases were in persons who used the public water supply. This outbreak is of interest not only because it was one of the first water-borne outbreaks to be reported, but also because of the very careful studies which were made to establish the source of infection. The water supply came from a well at the foot of a hill. On the other side of this hill was a valley through which ran a stream believed by some of the villagers to have a subterranean connection with the well in the village. As three cases of enteric had occurred in June and July in peasants living near this stream, the story of the supposed connection became important. Some 1,800 lb. of salt were poured into the stream and three hours later an increased salinity was detected in the village water supply, so that the water supply could have been contaminated from the apparently remote stream.

Water-borne outbreaks in this country were reported from Caterham in 1897, Worthing in 1893 and Maidstone in 1897. The details of these will be

known to many of you and need not be described. In the United States of America one of particular interest occurred in Pennsylvania in March-April, 1885, when 1,000 of the 8,000 inhabitants of a town were affected and 114 cases were fatal. So explosive was this epidemic that at its height over 100 cases a day were being diagnosed. As with Snow's investigations on cholera, the differential distribution of the cases between one source of water supply and another yielded important information. For example, in a street where all the houses on one side had a public water supply and all those on the other side had private wells, the cases were confined to those who lived on the public water supply side. The source of infection in this instance was a man who lived near the stream from which the water supply came and who had had typhoid in January, three months earlier. His excrement had been thrown on to the banks of the stream, where it remained frozen until March; with the thaw the whole accumulation of infected fæces from the case was washed into the stream and thence to the water main.

Here one person was sufficient to defile a water supply which came from a mountain stream draining almost uninhabited territory. It is said that this outbreak greatly stimulated the people of North America to safeguard their water supplies. Both there and in this country methods for the provision of safe water and the safe disposal of sewage began to be rapidly applied. In fact, there may have been at this time too much concentration on contaminated water supplies, for, though they were the commonest cause of large epidemics, we now know that there are many other modes of spread. Vaughan (1899) noted this in his investigation of the Spanish-American War epidemics and came to the conclusion that water played a very minor part in the spread of infection in American army camps. He considered that the main sources were the fouling of the ground with fæces and urine and the abundance of flies in the camp areas.

#### TYPHOID VACCINATION

It is against this background of growing knowledge of methods of spread that we have to consider the history of typhoid vaccination.

The idea that a killed culture of typhoid bacilli might induce immunity to the natural disease came to Wright after a discussion with Haffkine, who had used a somewhat similar method against cholera. Wright and Semple (1897) made their first injections in 1896 and published their report in the following year. Pfeiffer and Kolle are thought to have established priority, however, by their publication in 1896. Wright and Semple employed a diluted broth culture heated to 60° C. for five minutes and made careful observations on the antibody production in several of the men whom they injected. They compared the properties of the serum of the inoculated with serum from convalescent patients, and observed that the properties of the sera from the two sources were similar. They suggested that the agglutinating power of the sera could be used as an index of immunity, though they were careful to point out that agglutination was not necessarily the only or the most important factor in immunity.

As is well known, there were sometimes considerable local and general

reactions after the injection of these early vaccines. Cameron (1896-7) gave a good description of the reactions which occurred after he himself was injected in the loin. Three hours after the first dose he had local swelling and pain, with reddening of the lymphatics up to the axilla and down to the groin. Later he found his axillary and inguinal glands enlarged and tender. The second dose was followed by a rigor, severe headache, malaise and muscle pains for forty-eight hours. On examining his serum he found the agglutination titre had increased, and he concluded that if the injections prevented typhoid fever the temporary pain and discomfort were worth enduring.

Wright (1900) used his opportunities as a member of a Plague Commission in India in 1898-9 to inject some 4,000 soldiers in the Indian stations he visited. He used broth cultures of a virulent strain killed by heat and preserved with 1 per cent. lysol. The volunteers were generally the younger soldiers recently out from England, in whom, as you know, the incidence of infection was usually highest. He noted that some of the reactions were severe. So far as I can make out, only one dose of vaccine was given. The information on the subsequent history of the men was collected by many regimental medical officers, and in some units the results were said to be good, while in others they were inconclusive. An interesting feature of these trials was that Wright was unable to take sufficient vaccine with him from England and during his tour he prepared fresh batches. These batches were tested for toxicity in guinea-pigs, and as the stay of the Commission at each station was short the test guinea-pigs had to be carried along with the Commission so that Wright could gauge the toxicity of the newly-prepared vaccines. Wright was unhappy about the sterility of his vaccine and at each station he resterilized all his stock by heating it to 60° C. before he used it. I doubt if any immunologist would now expect one dose of a typhoid vaccine repeatedly heated to 60° C. to give any degree of protection. Wright, however, and others also, considered the results were encouraging, and in the South African War which began soon afterwards he and Leishman prepared vaccine, and supervised the administration of it to about 100,000 men.

It was thought that the South African War experience would settle conclusively the value of vaccination, for, as you know, enteric fever was rife during the whole campaign. In a mean annual strength of 208,000 men, 10 per cent. per annum were admitted as cases and about 1.5 per cent. per annum died of the disease.

When the results came to be analysed no agreement on the value of vaccination could be reached. There were many reasons for this, unconnected with the method of preparation of the vaccine. Sometimes only one dose was given, sometimes two doses were given. The recording of the injections was unsatisfactory, and the investigator had to depend on the soldier's statement. As can well be imagined, the South African War soldier was often unable to distinguish between injections of typhoid vaccine and the inoculation of vaccine lymph. Further, the diagnosis was frequently in doubt and no clear distinction could be made between typhoid fever and paratyphoid fevers which were common in South Africa, though paratyphoid bacilli were not included in

the vaccine. Leishman himself stated more than once between 1907 and 1910 (see, for example, Leishman, 1910) that it was impossible to say whether the inoculated and uninoculated men in South Africa had been exposed to the same degree of risk, and that no satisfactory evidence of the value of vaccination was obtained. Karl Pearson (1904) and Sir David Bruce (1905) made extensive investigations into the available figures and came to similar conclusions. Pearson stated that "[The results] fall into that range of intensity which would justify suspension of the operation [vaccination] as a routine method." Bruce was of the opinion that "the general statistics are not sufficiently extensive or exact to permit of any conclusions being drawn as to the utility of Wright's anti-typhoid inoculation." Five years later, in his address as President of the United Services Medical Society, Bruce was much more downright and said: "Anti-typhoid inoculation was in vogue during the last South African War, but it proved useless." Wright and others did not agree with the criticisms, and Wright and Pearson conducted an informative and sometimes acrimonious correspondence in the *British Medical Journal* for 1904.

Because of these critical reports, because of occasional severe reactions, and because of fear of the "negative-phase"—which fear appears to have been unfounded when a suitably small dose was given—anti-typhoid vaccination ceased to be offered to soldiers going abroad, and an Anti-Typhoid Committee under the chairmanship of C. J. Martin was set up to investigate the problem further. Leishman was the active member of this committee, and the Report (1912) reveals how much hard work he and his colleagues in the Army Medical Services at home and abroad carried out in the laboratory and the field between 1904 and 1909.

This Report is still considered to provide authoritative evidence on the value of typhoid vaccination in the field. It is quoted in the 1946 edition of Topley and Wilson's *Principles of Bacteriology and Immunity* and by Sloan Miller (1951). Along with it are usually mentioned the favourable comments by Greenwood and Yule (1915), who analysed the results in a series of papers read at the Royal Society of Medicine.

The Report is in two parts. Part 1 deals with laboratory experiments on the methods of preparation and testing of vaccines in the laboratory. From the information gained in the laboratory experiments it was decided that the best vaccine was a saline suspension of typhoid bacilli killed by heating to 53° C. for one hour and preserved with 0.5 per cent. lysol. Part 2 of the Report is a record of the plan and results of the field studies, and no one who has read it can fail to be impressed with the scope of the investigation and the magnitude of the effort required for its execution.

### *Plan of the Field Studies*

In order to test the vaccine exhaustively, the Committee decided that between 1904 and 1908 a specially appointed medical officer should be attached to each regiment of cavalry or infantry and each brigade of artillery about to go on foreign service. Each medical officer was instructed:

- (a) To accompany the unit to which he was attached on all changes of station for three years.
- (b) To inject *volunteers* in the unit before and after it left Britain.
- (c) To keep records of the men injected and of the number of cases in the injected and uninjected.
- (d) To carry out agglutinin tests on definite and doubtful clinical cases.
- (e) To attempt to confirm the cases by the isolation of the infecting organism.

Twenty-four units, mainly in India, were included in the investigation, and they were observed for 4-46 months after arrival at their foreign stations.

### *Results*

At the dates of the final reports from the medical officers engaged in the studies there were, in round figures, 10,000 men in the injected group and 9,000 men in the uninjected group. Fifty-six cases occurred in the injected and 272 cases in the uninjected, giving attack rates per 1,000 men of 5.4 in the injected and 30.4 in the uninjected. The difference was highly significant when statistical tests were applied. In the Committee's opinion the difference could only be attributed to the preventive effect of the injections, and they recommended that anti-typhoid vaccination should be extended immediately to all members of the forces. This recommendation was carried out on a voluntary basis, and on this voluntary basis it still continues:

Before we accept the findings of the Committee it is necessary to examine the methods used in the collection of the information and to decide whether the conclusions were fundamentally sound, for no statistical test can be considered valid if the information on which it is based has been subject to error, however unforeseeable that error may have been.

The criteria which from recent experience are necessary for a strictly controlled study may be briefly defined as follows :

- (1) The men to be injected and the men to serve as controls must be chosen so that when considered as groups they are alike in every relevant respect.
- (2) The groups must be subject to the same risk of exposure.
- (3) The two groups must be observed with the same thoroughness over the same period.
- (4) The clinical diagnosis of disease in the two groups must if possible be confirmed by objective means such as the isolation of the infecting organisms.
- (5) Neither the observers nor the subjects observed should know until the end of the investigation whether a particular person belongs to the test or the control group.

These criteria were not satisfied in the 1904-1908 studies : the importance of some of them was not recognized, and others—for example, the isolation and

TABLE I.—UNITS 1 TO 7

Unit	Date of arrival abroad	Period of observation (months)	Strength on arrival at the foreign station		Strength at the end of the trial		Number of cases		Attack rate per 1,000 men (1)		Attack rate per 1,000 men (2)	
			Injected	Not injected	Injected	Not injected	Injected	Not injected	Injected	Not injected	Injected	Not injected
1	Dec. 1904	42	106	777	198	815	12	68	61	83	113	88
2	Oct. 1905	46	130	446	460	160	18	96	39	600	138	215
3	Dec. 1905	31	46	310	202	128	0	7	0	55	0	23
4	Sept. 1906	34	211	388	377	257	4	6	11	23	19	15
5	Oct. 1906	34	90	618	540	214	2	10	4	47	22	16
6	Oct. 1906	33	149	789	589	321	5	24	8	75	34	30
7	Nov. 1906	31	62	996	311	797	1	12	3	15	16	12
			794	4,324	2,677	2,692	42	223	16	83	53	52

(1) Based on the number of men in each group at the end of the trials (the method of calculation used by the Committee).

(2) Based on the number of men in each group at the beginning of the trials (the method used by Greenwood and Yule).

identification of the organism—were difficult to carry out. In some cases a bacteriological diagnosis was made. In many, reliance was placed on serological tests, the results of which in injected men are still difficult to interpret. In those days it was also difficult to distinguish between typhoid and paratyphoid infections by serological examinations.

The incidence of infection in inoculated volunteers was compared with that in uninoculated non-volunteers, and such a method of comparison would not now be accepted as valid as volunteers, by the fact that they have volunteered, must differ from those who have not volunteered. Pearson considered this factor of the greatest importance, and suggested in 1904 that in studies of this kind only half the volunteers should be injected and that the incidence of disease in injected volunteers should be compared with that in uninjected volunteers. If this had been done, some criticisms would have been prevented. On the other hand, Greenwood and the members of the Anti-Typhoid Committee believed that both volunteers and non-volunteers in the same unit were exposed to the same risk of infection. There is no means now of determining the effect of the method employed on the accuracy of the results, but experience has shown that it is one which frequently leads to false conclusions on the efficacy of a vaccine. In one unit in the investigation (Unit 1, see Table I) the incidence of disease in the volunteers was similar to or greater than that in the non-volunteers. The volunteers were injected with the "old-type" vaccine killed by heating at 60° C. for five minutes, which the investigators considered less effective than



the "new-type" vaccine used for the injections in the other 23 units. If it is accepted that the old-type vaccine was less effective than the new type, these results could be taken to indicate that at least in some units the risks of infection in the two groups were similar.

The next point of importance to be considered is whether the men in the two groups were kept under observation for the same length of time. If 100 uninjected men were observed for twenty-four months and 100 injected men were observed for only six months, it is not unreasonable to suppose that more cases might occur in the uninjected than in the injected, because the uninjected presumably had a greater chance of being exposed in two years than the injected had in six months. In some of the units, particularly those which were included in the early part of the study, many of the men were injected towards the end of the trials and were in the injected group for a few months only, though they might previously have been in the uninjected group for about two years. Greenwood and Yule were aware of the influence of this procedure on the results and they compensated for it by relating the numbers of cases, not to the numbers of injected and uninjected men at the end of the study as was done in the Report, but to the numbers in each group at the beginning. As men were moved from the uninjected to the injected group during the study, the numbers in the injected group were less and in the uninjected group were greater at the beginning than at the end, so that calculation of attack rates on the numbers in each group at the beginning favoured the uninjected. By this method of calculation the attack rates were for the injected 8 per 1,000 men and for the uninjected 23 per 1,000 men—a threefold difference compared with the sixfold difference given in the original report. The differences obtained by Greenwood and Yule's method were still significant. If, however, the units are divided into three groups according to the date on which the observations began (before the end of 1906, during 1907, and after the end of 1907), as has been done in Tables I, II and III, we find that in the first seven units (Table I) there is no difference between the injected and uninjected if the rates are calculated on the numbers of men in each group at the beginning of the period of observation. There is, however, a difference in the incidence in injected and uninjected men in the units listed Tables II and III. The lack of difference in the units in Table I may be due to the test being too stringent, for it is evident that, in contrast to the later units, comparatively few of the men in the earlier units had volunteered to be injected by the time they arrived at their foreign stations. On the other hand, it is clear from the records of Unit 2 (Table I) that the attack rate in the uninjected of 600 per 1,000 men, based as it is on the number of men not injected at the end of the study, was due in great part to the fact that by the end of the study only 160 of about 600 men were left uninjected. It is impossible to determine from the report at what stage of the observations the uninjected men in the early units began to volunteer to be injected, though one of the factors which influenced the men was the occurrence of typhoid. It is, for example, stated that "this [obtaining volunteers] was found to be an easier task when the unit in question was actually serving in a station where

enteric fever was present." In these circumstances men injected during or after an outbreak could only have been among those not suffering from the disease, and they may not have owed their subsequent immunity to the injections—they may have already had a natural immunity derived from a sub-clinical

TABLE II.—UNITS 8 TO 14

Unit	Date of arrival abroad	Period of observation (months)	Strength on arrival at the foreign station		Strength at the end of the trial		Number of cases	
			Injected	Not injected	Injected	Not injected	Injected	Not injected
8	1907	28	300	185	611	395	0	7
9	"	21	294	593	309	618	0	7
10	"	21	240	123	235	119	2	6
11	"		No cases in either group					
12	"	18	220	425	485	135	3	2
13	"	19	716	283	890	69	2	0
14	"	9	206	429	209	424	0	3
			1,976	2,038	2,739	1,760	7	25

## ATTACK RATES

	Injected	Not injected
Attack rate per 1,000 men (1) ... ..	2.6	14.2
Attack rate per 1,000 men (2) ... ..	3.5	12.3

(1) Based on the number of men in each group at the end of the trials (the method of calculation used by the Committee).

(2) Based on the number of men in each group at the beginning of the trials (the method used by Greenwood and Yule).

TABLE III.—UNITS 15 TO 24

Unit	Date of arrival abroad	Period of observation (months)	Strength on arrival at the foreign station		Strength at the end of the trial		Number of cases	
			Injected	Not injected	Injected	Not injected	Injected	Not injected
15	1908	18	439	404	460	387	0	3
16	"		No cases in either group					
17	"	9	171	404	242	319	0	1
18	"		No cases in either group					
19	"	9	301	697	422	568	0	1
20	"	7	283	586	285	605	0	5
21	"	8	601	403	912	92	4	11
22	1909	6	471	451	510	399	2	0
23	"	5	253	602	253	652	0	1
24	"	4	561	349	702	179	1	2
			3,080	3,896	3,786	3,201	7	24

## ATTACK RATES

	Injected	Not injected
Attack rate per 1,000 men (1) ... ..	1.8	7.5
Attack rate per 1,000 men (2) ... ..	2.3	6.2

(1) Based on the number of men in each group at the end of the trials (the method of calculation used by the Committee).

(2) Based on the number of men in each group at the beginning of the trials (the method used by Greenwood and Yule).

dose of infection before the injections were given. It is particularly unfortunate that the evidence from the first seven units is so difficult to interpret because 42 of the total of 56 cases observed in the injected men and 223 of the 272 cases observed in the uninjected men during the whole period of the investigation occurred in these units.

Only 14 cases in the injected and 49 in the uninjected occurred in the units which arrived at foreign stations after the end of 1906 (Tables II and III). Here the numbers of men in the injected and uninjected groups at the beginning and the end were more equal, and by Greenwood and Yule's method of calculation the attack rates in the two groups were 2.8 per 1,000 and 8.3 per 1,000—again a threefold difference in favour of the vaccinated. This is the same as Greenwood and Yule obtained by including all units in their calculations—but it is now shown to be based on a very small number of cases. Corrections for the duration of the observations therefore reduce the difference in attack rates between the two groups, but do not dispose of it.

The influence of other factors must now be taken into account. In the calculations it has been assumed that the same men were present in the units at the beginning and end of the study. This was by no means the case, for it is stated in the report that there were marked fluctuations in the strength of the injected and uninjected men from time to time due to postings to and from the units, to time-expired men being discharged, to new arrivals from the United Kingdom, to sick men being admitted to hospital and to the many day-to-day changes which are common to all units in the Services. No method of analysis can take account of these changes, for no information on the numbers of men concerned or of the dates of their entry or exit is given.

The accuracy of the diagnosis must also be considered in some detail. It is stated that "Widal's reaction had been carried out in every instance" and that in a "large proportion of the cases the attempts which had been made to isolate the typhoid bacillus during life from the blood or excreta had been successful." The difficulties in interpreting the agglutination reaction in injected men have already been mentioned, and no indication of the numbers constituting the "large proportion" from whom the organism was isolated or of their distribution between the injected and uninjected men is given.

Only in two units is there an indication. In Unit 9 all of seven cases in the uninjected were confirmed bacteriologically, and in Unit 14 the typhoid bacillus was isolated by blood culture from one case and a paratyphoid bacillus was isolated from another during the same outbreak. In the absence of information on the numbers of cases confirmed bacteriologically in the injected and uninjected it is permissible to have doubts about the invariable accuracy of the clinical diagnosis as the observers, especially those in charge of the units which entered the study in the later stages, were undoubtedly convinced that the vaccine was of value. In these circumstances it is difficult to rely upon the absence of unconscious bias on the part of the observers. They might, for example, have believed that a mild or atypical case could not have been typhoid fever if the patient had been vaccinated.

In these extensive studies, therefore, the value placed on the evidence that the vaccine was responsible for a threefold reduction in the incidence of typhoid fever in the injected men depends on the importance attached to the following points :

- (1) The injected men were volunteers and the uninjected men were not volunteers.
- (2) The diagnosis may not always have been accurate.
- (3) Men were transferred to and from units during the period of the study, but the numbers of men concerned and the time spent by them in the units is not known.
- (4) The observers believed that the vaccine was of value and may have been biased when diagnosing cases in injected men.

### *Severity of Attack*

In the report information is given on the severity of the illness in the two groups, and it is concluded that 66 per cent. of the cases in the injected men were mild compared with 29 per cent. in the uninjected men and that 34 per cent. in the injected were severe or fatal compared with 71 per cent. in the uninjected. As the report describes the severity of the illness in only 202 of the 272 cases in the uninjected men, and as no information on the other 70 cases is given, the information on severity cannot be interpreted satisfactorily.

### *Seventeenth Lancers*

So far the trials have been described as a whole, but it is now necessary to examine the information about Unit 2 (17th Lancers) in some detail. It has already been mentioned that the incidence in the uninjected men during the whole of the duration of the trial in this unit (see Table I) is of little value as recorded in the 1912 Report, but Captain Luxmoore's report of the experience of the unit a few weeks after arrival at Meerut is of interest (Luxmoore, 1907). The men arrived early in October, 1905, and at that time 130 other ranks had received one or two injections and 360 were uninjected. (The figure for the uninjected is less than that in Table I, because I excluded a number of men who arrived in the unit in December after cases of typhoid had begun to occur.) The unit experienced an enteric outbreak which was clinically typical of typhoid fever and, though there was no bacteriological evidence, there was little doubt that the disease was in fact typhoid fever and not paratyphoid fever. The first cases occurred before the end of October, and by the end of December a total of 46 had been diagnosed. Only one of the cases was in the injected group and that was in a soldier who had received only one dose. The attack rate therefore was 13 per cent. in the uninjected and 1 per cent. in the injected. If we were certain that the injected and uninjected men were exposed to the same risk, we should be justified in considering the results most promising. There are two points, however, which need to be considered. The first is that 17 of the cases occurred in a detachment of men who went on special duty for about a week to Delhi. Karl Pearson has said (see Maynard, 1908-9) that this may

have been important, for if only uninjected men had gone to Delhi they might have been at greater risk. But from reading Captain Luxmoore's report of the outbreak I think it is reasonable to assume, taking into account the dates of onset, that at least some of the Delhi contingent were infected before they left Meerut. The second point is whether the injected men—who were of course volunteers—should be considered “similar in all respects” to the uninjected men who did not volunteer. The Committee's opinion and that of Greenwood and Yule on this point has already been stated, but no one can now be certain of the real answer. Karl Pearson considered that comparing volunteers with non-volunteers destroyed the value of the observations. There is no doubt that volunteers in the 17th Lancers were obtained with great difficulty. Colonel Leishman personally visited Edinburgh—where the unit was stationed before embarkation—and after obtaining what is described as the “cordial co-operation” of the colonel, he and Captain Luxmoore gave a series of lectures to the men and obtained the consent of between one-quarter and one-third of them. I was privileged recently to discuss the situation in the 17th Lancers with Captain—now Surgeon-Colonel—Luxmoore. He thought that the volunteers were representative of the unit except that most of them were the younger soldiers ; the older men had heard of the severe reactions experienced by those inoculated in the South African War and had refused to be injected. As enteric has usually been commonest in the recently-arrived young soldier in India this is a point in favour of the validity of the results. My own impression is that the volunteers in this unit may have been more mindful of risks than the non-volunteers, especially as vaccination was commended by the Officer Commanding the unit and as nearly all the officers volunteered for inoculation (though they are not included in the analysis of the results). In this, the only unit where the conditions in the two groups was similar in most respects, the interpretation of the results depends on whether we believe that the injected volunteers were exposed to the same risk as the uninjected men. On this point there is room for different opinions.

#### *Prevention of Spread of Infection in the Indian Army*

It was on the basis of the results of the 1904-1908 studies that vaccination was offered to volunteers in the Indian Army, and this coincided with a reduction in the incidence of enteric fever. For example, between 1890 and 1899 the admissions per 1,000 men varied annually from 37 to 19 ; in the period 1900 to 1906 from 20 to 13 ; and in the years 1907-1912, when vaccination became common, the annual admission rates were respectively 13, 15, 8, 4, 2 and 2. How much of this decrease was the result of vaccination ? I said at the beginning that vaccination against typhoid was introduced at a time when knowledge of the modes of spread was rapidly increasing. In 1902 and 1903 Koch and his co-workers in Alsace-Lorraine and other areas in south-west Germany, in their extensive efforts to control the disease, demonstrated for the first time conclusively that :

- (a) The human host was the storehouse of infection ;

- (b) The life of the organism outside the human body was very short ;
- (c) Convalescent carriers were frequent ;
- (d) Some patients became chronic carriers ;
- (e) Some carriers had no definite history of a clinical attack.

Semple and Greig (1908) were asked by the Government of India to make a similar investigation, and they published a most informative paper in which they demonstrated : (1) That a proportion of convalescent cases excreted the organism for long periods, sometimes intermittently ; (2) that four outbreaks they investigated during their inquiry were due to carriers, two of them to carriers in cookhouses ; (3) that nursing orderlies in enteric wards—who were seconded for nursing duties for six months and then returned to their (non-medical) units—could become temporary excretors or carriers with or without a history of a definite clinical attack, and were sometimes returned to their units while still excreting the organism.

As a result of their findings, which were probably well known in India before their paper was published, the methods for the prevention of the spread of infection in the Army in India were changed. Aldridge (1909) described the new methods. "Suspected cases are isolated in an observation ward, diagnosed cases in a special ward and convalescent cases in a separate ward." The bowel and urine discharges of cases were placed immediately into disinfectant, and the water used for washing the sick was also disinfected. The sweepings of the wards were burned and the excreta of the cases boiled before being disposed of. Convalescent patients were sent to a hill station and examined regularly until negative and barrack-room bedding and latrines were disinfected. All the men in the same tent or barrack room as that in which the case occurred were segregated and inspected frequently for one month. Measures in all units included the periodical examination of food-handlers, the covering of food-stuffs with gauze and the substitution of cresol and water for dry earth in the latrine pans.

Firth (1911) mentioned that new arrivals in units were segregated for a period, and that between 1909 and 1910 the convalescent depot had detected 31 carriers among convalescent cases. Faichnie (1915) reported that for many years before the introduction of vaccines he had been impressed with the reduction of incidence which followed the adequate disposal of fæces, for example by carefully supervised trenching, and thought the fall in incidence was associated with the lessening of the fly population. In support of his contention he quoted figures for the stations at Ambala, Nasirabad and Meerut where, after the introduction of adequate trenching and efforts to reduce the fly population, the incidence fell from about 30 per 1,000 (at which level it had remained for the previous twenty years) to between 2 and 5 per 1,000. There were many other reports telling of the activities of hygiene-minded medical officers about this time. One (Hayes, 1912) mentioned that in an outbreak in Reading the mops used in the urinals were also used to wipe the barrack-room table tops. Harvey (1915), speaking of earlier days, reported

that "There was no issue of latrine paper to soldiers. There were no facilities for washing hands in or near latrines. Pipes, mugs, clothes and rifles were all used in common."

### *Purification of Water*

While latrines, carriers and food-handlers were receiving increased attention, the purification of water supplies by chemical means was also being investigated. Houston and McGowan had chlorinated the water supply as an emergency measure in an outbreak at Lincoln in 1905. Sims Woodhead (1910-11), Thresh (1909-10) and others had made investigations into the purification of water supplies by ultra-violet rays, ozone, hypochlorites and free chlorine in bleaching powder. In the summer of 1914 a change-over from the purification of water by filtration to purification by chlorination was being arranged in the Army, and by the autumn of that year all water supplies to the troops in France and in other theatres of war were being chlorinated.

This was in striking contrast to the water supply situation in the South African War, where instructions for boiling water were issued but little or no fuel for the purpose was provided, where the filter candles supplied invariably clogged or were broken soon after the arrival of the units in South Africa, where instructions on the dangers of failure to observe sanitary precautions were generally disregarded and where officers and men regularly drank foul water on the march (Simpson, 1910).

At the outbreak of the First World War, therefore, enteric was being attacked on three fronts—personal, unit and cookhouse hygiene ; purification of water supplies ; and anti-typhoid vaccination. It is not possible now to allocate to each the proper share of credit for the reduction in the incidence of enteric fever in war. It is unfortunate that the evidence for the true value of typhoid vaccination rested, as far as field studies were concerned at that time, on grounds which would now be considered only to be sufficiently hopeful to warrant further study by means of strictly controlled trials. Let me make it clear that criticism of the method by which the study was made in the field does not necessarily mean that the vaccine used then was ineffective. It does mean, however, that, unless supported by other good evidence, the favourable reports of the results apparently achieved in the 1904-1908 investigations should be accepted with caution.

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# SOME OBSERVATIONS ON THE ADMINISTRATION OF T.A.B. VACCINE

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PREVENTIVE inoculation against typhoid fever has been used on an ever-increasing scale since its discovery by Wright and Semple in 1897. Until recently its efficiency has been accepted and its use has been standard procedure in the Armed Forces for many years. In the Army, doses of T.A.B. vaccine of strength *S. typhi* 2,000 million and *S. paratyphi A* and *B* 1,500 million organisms per ml. are given on entry (0.2 ml.), after a period of one month (0.4 ml.), and again after a further interval of six months a third primary injection (0.2 ml.). Thereafter annual booster doses (0.2 ml.) are given.

All Army medical officers are aware that unpleasant reactions to T.A.B. may develop after the initial dose. Furthermore, Felix (1), besides pointing out that the reactions have a decided nuisance value, states that they do not confer more adequate protection. Side effects following the second dose also occur and may be more severe than following the first (2).

It was our aim to find the average response to a third dose of T.A.B. and how it compared with previous injections. This group we chose because we thought that such men would have minimal symptoms, having already had two primary doses in the previous twelve months. Further, we were anxious to discover the effect of the administration of alcoholic beverages when given with T.A.B. It is popular belief that alcohol may increase the side effects of vaccination, this view being particularly prevalent amongst medical officers. Actual evidence of this point is rather scarce, although Bamforth (3) states that alcohol appears to "intensify post-vaccination headache."

Half of our subjects received alcohol in the form of beer or whisky, the choice being left to the individual, although those unused to its effects were excluded from the "alcoholic" group. The amount of alcohol given (two pints of beer, proven strength 5 per cent. alcohol, or whisky, four ounces of 40 per cent. alcoholic content) was considered to be within reasonable limits of what a young recruit might drink, having regard to his age and finances. The two forms of alcohol in the above amounts were of approximately equal alcoholic content.

## METHOD

Our 60 patients, *i.e.*, 30 controls and 30 "alcoholic," were fit convalescent hospital patients drawn from three infantry battalions and supporting arms.

They were all due for the third T.A.B., the interval since the second being from five to twelve months. The vaccine used was the standard type "A" (alcohol-killed and alcohol-preserved organisms) (4) because of the milder reactions produced and its proved satisfactory property of antibody production (1). The injection was accurately measured in all cases by means of a "tuberculin" syringe; each was given at the same time of day by the same medical officer, using a similar needle, the site being subcutaneously at the insertion of the left deltoid muscle. For twenty-four hours before injection the patients were placed on four-hourly T.P.R. charts in order to establish a normal base-line. Subjects were allowed to be up and about thereafter, but were given no duties. T.P.R. charts were continued for a further forty-eight hours, and during this time each was seen twice and questions regarding side effects asked, while inquiries were also made as to the effects of previous inoculations and the conditions under which they were given.

In addition, the "alcoholic" group received two ounces of whisky or one pint of beer on two occasions after injection, at intervals of two and six hours.

The heights and weights of all subjects were recorded.

## RESULTS

The following side effects were noted :

1. *Pyrexia*. This occurred in 30 of our total number of subjects, *i.e.*, 50 per cent. there being 15 controls and 15 "alcohols" affected. Pyrexia was mild (99 to 100° F.) in 12 of the 15 "alcohols" and in 8 of 15 controls. Moderate fever (over 100° F.) was found in 3 "alcohols" and in 7 controls. The highest recorded temperature was 102.2° F.

TABLE I.—GRADES OF PYREXIA ENCOUNTERED FOLLOWING T.A.B. INOCULATION IN 30 CONTROLS AND 30 "ALCOHOLS."

Group				No. of pyrexial reactions	Mild (99-100° F.)	Moderate (100° F. +)
Controls	...	...	...	15	8	7
"Alcohols"	...	...	...	15	12	3

In both groups it seemed that febrile responses were, not unreasonably, more common in those below average weight. The average of each group was practically identical, and of the whole 60 was 141½ lb. (Average weight of 18-year-old men is 149½ lb. (5), which shows our selection to be somewhat under average.)

TABLE II.—DISTRIBUTION OF PYREXIAL SUBJECTS ONLY IN RELATION TO WEIGHT

Group				No. of pyrexial subjects under average weight	No. of pyrexial subjects of average weight or above.
Controls	...	...	...	11 (73%)	4 (27%)
"Alcohols"	...	...	...	9 (60%)	6 (40%)
Total	...	...	...	20 (66%)	10 (33%)

The average weight of the pyrexial subjects of both groups was 138.5 lb. and that of the apyrexial was 144.5 lb.

2. *Duration of Pyrexia.*—Periods of fever varied considerably, the limits being 4 and 56 hours. The average duration in the “alcohols” was 13 hours and in the controls 25 hours, three readings of 48 hours and over being responsible for this latter rather high figure. A fever lasting 24 hours or more was not uncommon, occurring in 20 per cent. of the 60 subjects.

3. *Specific Symptoms.*—In this group the commonest complaints were: (a) Local pain at the site of injection, (b) headache, (c) gastro-intestinal upsets, mainly nausea and vomiting, and (d) muscular pains in that order of frequency. Local reactions were seen to some extent in almost 100 per cent. of cases and were generally mild.

Headache occurred in 13 of the “alcohols” and in 16 of the control group. Two “alcohols” said that their headaches were severe, but neither was kept awake at night or asked for analgesics.

Nausea was an infrequent symptom, occurring in only 6 subjects—2 “alcohols” and 4 controls, vomiting accompanying in one of the latter.

Muscular pains were complained of by only one subject, these being confined in him to the lower limbs.

Time of onset of symptoms varied widely within each group, occurring from 2 to 24 hours following the injection. Most subjects with reactions began to experience symptoms either 7 or 8 hours from the injection, *i.e.*, 9 or 10 p.m., or on the following morning. Rarely symptoms were delayed for 24 hours or occurred within 2 or 3 hours of injection.

#### SUPERVISION OF PREVENTIVE INOCULATION

*Memorandum on Immunological Procedures* (1952) states that the following precautions should be taken when T.A.B. is given :

1. Inoculation should be performed at a late hour.
2. A period of 36 hours off duty and confinement to barracks enforced.
3. A warning against the drinking of alcohol should be given.

Of our group 68 per cent. stated they had not been warned of the possible effects of alcohol, and nearly 50 per cent. claimed that they had no time off after previous inoculations. Of course, many who had previous reactions would be likely to insist that they had not had ample facilities for rest, but what did strike us was the complete lack of uniformity in the precautions taken. Some were told to “walk it off,” others were put to cleaning barrack-room floors, supposedly to exercise the injected arm. Some also who were given injections in the evening were expected to be on parade the next morning, when symptoms may well be commencing, as we have shown.

Seven of our subjects—2 “alcohols” and 5 controls—declared that their reactions to the third T.A.B. were worse than those of the first or second. The

majority, as expected, stated that the after-effects were much decreased, and indeed 33½ per cent. of the whole group, apart from local pain at the site of injection, admitted to no trouble whatever.

#### DISCUSSION

It has been stated (6) that T.A.B. "in rare cases gives rise to some pyrexia with even pallor and collapse." It would seem from this investigation, which is admittedly on a small scale, that this is far from true even following re-inoculation. As we have shown, moderate pyrexia and headache often lasting many hours are quite common side effects following the third dose of T.A.B., even when subjects are on the lightest of duties. Reactions to the first and second inoculations of the primary series are generally much worse (2).

Furthermore, it does not seem that moderate amounts of alcoholic beverage consumed after T.A.B. injections have any appreciable effect. One would be inclined to suppose that the effects of alcohol and T.A.B. following the initial and the booster doses might also be no greater than the effects of T.A.B. alone. The only symptom in our group which seems to have been accentuated in any way is the very immeasurable headache, which two of the "alcohols" described as severe.

What does seem important is the varying instructions given to recipients as to how they should behave following immunization. Instructions set out do not appear to be followed. Admittedly it is difficult to put large numbers of men off duty, although one cannot help thinking that much trouble might be avoided in this way.

Granted, then, that even re-inoculation with small doses of T.A.B. may cause moderate reactions, how does this affect future policy? Surely when one considers (a) that chloramphenicol is a remarkably effective drug in the treatment of the enteric fevers, (b) that injections of T.A.B., apart from causing unpleasant and worthless reactions, may rarely cause severe encephalopathies and encourage the development of poliomyelitis (7), (c) that the antibody titres produced by inoculation interfere with the serological investigation of enteric cases, (d) that some observers have cast doubts on the efficacy of T.A.B. inoculation as a protective measure, not only in the prevention of cases of enteric fever but also in moderating the clinical course of established cases (8, 9)—it is time to consider critically the value of T.A.B. and, if we use it, to ensure that instructions for the protection of recipients are carried out.

#### CONCLUSIONS

An investigation into the side effects of the third inoculation of T.A.B. vaccine was carried out. It would seem that:

1. Reactions of moderate severity may occur even when using small doses, particularly in those recipients under average weight.
2. Alcohol in moderate amounts had little effect on the severity of such reactions.

3. Precautions taken are, in fact, not uniform among units, and do not in most cases offer maximum protection from reactions.

The question of the preventive value of T.A.B. is raised.

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## A CASE OF TRANSVERSE MYELITIS FOLLOWING T.A.B. INOCULATION

BY

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NEUROLOGICAL complications following T.A.B. vaccination are rare. Miller (1954) has recently reviewed neurological sequelæ of prophylactic inoculation. He has summarized 49 neurological syndromes following use of T.A.B. vaccine from the literature, to which he has added one case of his own. He includes one case of transverse myelitis, reported by Lemke (1943). In view of this rarity, a case is reported here in which a transverse myelitis of the cervical spinal cord occurred in a National Service soldier, beginning fifteen days after his receiving a second injection of T.A.B. vaccine.

### CASE NOTES

Private D., a National Service man aged 18 years, of two months' service, was admitted to Chester Military Hospital on 6th January, 1954, complaining of numbness and weakness of the legs and arms.

*Family History.*—Mother reported to have had brain fever, aged 8 years. Father died when patient was aged 8 years. No sibs.

*Past History.*—Had never been ill before. Left school at the age of 15 years. He tried various jobs, but finished up by working underground in the mines, where he was training to be a fireman. He did this for one year, leaving it to join the Army.

He joined the Army in November, 1953, and received inoculations and vaccinations as follows :

19th November, 1953 ... Schick Test : Negative.

28th November, 1953 ... T.A.B. 0.2 ml.  
Tetanus Toxoid : 1.0 ml.

4th December, 1953 ... Vaccination : Typical primary vaccination.

21st December, 1953 ... T.A.B. : 0.4 ml.

All inoculations and vaccinations were in the left arm.

On 5th January, 1954, the day before admission, he was out on an outdoor exercise. It was very cold, and he noticed that he felt "freezing cold" and was not shooting as well as usual, having difficulty in holding his rifle. On return to his barracks in South Wales, however, he felt perfectly well and went to bed feeling quite fit. He awoke during the night and noticed a feeling of tightness across his upper chest. He went to sleep again and on awakening in the morning he felt that his arms were very stiff, with pain under both armpits. He tried to

get out of bed and found that his arms were weak ; he was unable to take any weight on them, to grip objects or to extend his arms, which were in a position of flexion across his trunk. Although he was able to stand, his right leg felt numb and weak. He was dressed by his mates and helped to breakfast ; he then noticed his right leg was weak and uncontrolled. He was carried back to his bed and seen by his unit Medical Officer, who recorded temperature of 97.4° F., pulse 80, a vague transient headache, weakness of extension of both forearms and of grip, absent triceps jerks, a flexor plantar response on the left side, and a doubtful plantar response on the right side. Loss of sensation to pinprick over the right leg and both hands was noted. Nil else abnormal was recorded.

He was transferred by ambulance car to Chester Military Hospital. He stated his left leg began to feel cold and numb *en route*, and on arrival at Chester he could not use it.

There was no history of sore throat or cough, or of injury. He had been constipated for one day.

*Physical Examination* on admission late on 6th January, 1954, showed a pleasant lad, intelligent, co-operative, not drowsy. Temperature was 98° F., pulse rate 70, respiration rate 20.

Examination of the central nervous system showed no abnormality in the cranial nerves. There was loss of power of the abductors of both shoulders, and flaccid paralysis of all muscles of the arms and forearms with bilateral wrist drop. He was unable to sit up and intercostal movements were diminished. There was complete flaccid paralysis of the left leg, paralysis of extension of the right hip and leg and weakness of flexion of the right hip and leg. Both triceps jerks were absent, the biceps jerks and supinators were weak, the right knee jerk was diminished and the left knee jerk and both ankle jerks were absent. All abdominal reflexes were absent and plantar reflexes were not obtained. Sensation was diminished to pinprick and cotton-wool below the second thoracic dermatome approximately. Other systems showed no abnormality.

By morning on 7th January, 1954, all reflexes were absent, the upper level of loss of sensation to pinprick was more definite at the level of the second thoracic dermatome, and it was noted that loss of sensation was greatest peripherally. Retention of urine occurred.

Lumbar puncture produced a clear colourless fluid, pressure was 140 mm. with negative Queckenstedt test. Protein was 45 mgm. per 100 ml., no excess of globulin was found, sugar was 70 mgm. per 100 ml., chloride 760 mgm. per 100 ml., cell count was two lymphocytes per c.mm., W.R. and Lange were negative. Blood count showed 10,400 white blood cells per c.mm., polymorphs 58 per cent., lymphocytes 38 per cent., monocytes 3 per cent., and eosinophils 1 per cent. B.S.R. was 3 mm. in the first hour (Westergren). Throat swab showed normal commensals. Catheter specimen of urine was normal chemically and sterile on culture. Radiographs of cervical spine were normal.

Routine changing of position was instituted. Four-hourly temperature

charting, intake and output chart, daily enema, twice-daily catheterization, splinting of extremities and physiotherapy were all commenced, with vitamin B1 given parenterally. Penicillin 500,000 units four-hourly intramuscularly was commenced.

On 11th January, some general improvement was noticed, and knee jerks and biceps jerks were obtained. On 14th January it was noticed that the right plantar response was definitely extensor whilst the left was equivocal. Repeat of lumbar puncture showed protein content of 70 mgm. per 100 ml., no excess of globulin, 3 lymphocytes per c.mm. Other constituents were normal and pressure was 140 mm.

Improvement in strength and power continued gradually and on 22nd January he was passing urine normally, and by 26th January he had regained complete sphincteric control. All reflexes were now present though weak, especially the left triceps jerk. The right supinator jerk was inverted. Early in February both plantar responses were extensor and deep tendon jerks became brisk in the legs only, with some spasticity in the left leg. Repeat lumbar puncture on 10th February showed clear fluid with pressure of 160 c.mm., protein 60 mgm. per 100 ml. and 6 lymphocytes per c.mm.

On 23rd February a detailed review showed considerable improvement. He was walking with assistance. There was weakness of the left trapezius, of abduction, internal and external rotation of the left shoulder. The left triceps was not acting, the right triceps was weak; there was still only slight power in extension of the wrists, best on the right side, whilst flexion of the wrists and all movements of the hands were nil. There was considerable wasting and weakness of the sternocostal head of the left pectoralis major. The spinal muscles had regained strength, though not completely; intercostal muscles above T4 were now contracting well. The legs still showed marked weakness in the hips and flexors of the left knee, and there was definite spasticity in the left leg. Examination of sensation then showed diminished sensation to pin-prick below T2 with greatest loss over the right leg; vibration sense was diminished in the right leg. No change in thermal sensitivity was found. The triceps jerks, especially the left, were diminished. The right supinator jerk was inverted. Knee jerks were exaggerated, both ankle jerks were brisk and both plantar responses were still extensor. At this time it was noted that the left cremasteric reflex and left lower abdominal reflex could now be elicited.

Improvement continued slowly, and on final discharge from Chester Military Hospital in October, 1954, he walked well and looked after himself unaided. He still had difficulty in use of the hands. There was some wasting of both groups of spinati bilaterally, of both pectorals with marked atrophy of the sternocostal head of the left pectoralis major, of the left triceps and of the small muscles of both hands. There was slight weakness of the left shoulder, especially of abduction above the horizontal and of internal rotation, and of the right shoulder to lesser degree. Weakness of extension of the left elbow, of extension of the left wrist and fingers, of flexion of the right wrist and fingers was marked, and there was little power in the intrinsic muscles of both hands and thumbs,



especially on the left side. All intercostals contracted well, and spinal muscles were relatively normal. There was some wasting and weakness in the left buttock, with slight weakness of dorsiflexion of the left ankle and extension and adduction of the left hip. Sensory loss to pinprick had practically recovered, but there was still a level in the region of T6-7. The right leg was still less appreciative of pinprick. Vibration sense was normal. Reflexes showed increased tendon jerks apart from a very weak left triceps jerk and weak right triceps jerk. Both plantars remained extensor and abdominal reflexes were absent on the right-hand side. Bladder and bowel function were normal.

#### DISCUSSION

It was considered that the spinal cord lesion was probably a thrombosis affecting the cervical cord. The absence of other apparent cause of the transverse myelitis—*e.g.*, trauma, syphilis or other infection, bacterial or viral—and its relatively close sequence to his T.A.B. and other inoculations led to the consideration that it might be associated with those inoculations.

— A post-vaccinal condition was thought to be unlikely as the cause. Post-vaccinal encephalomyelitis most commonly occurs following primary vaccination, especially in adults. Its incidence has been reported as 9 cases in 75,000 vaccinations (Fyfe and Fleming, 1943) and 45 cases in over 5,000,000 vaccinations (Greenberg and Applebaum, 1948). A total of some 815 cases have been recorded out of at least 30 million vaccinations. These cases are predominantly of affection of the brain, spinal cord and meninges, with an almost constant period of 10-12 days elapsing after vaccination, though isolated extremes of 2-26 days have been recorded. Though fatal in from 20 to 50 per cent. of cases, when recovery occurs this takes place rapidly and completely. Included are three cases of transverse myelitis. All cases occurred on the twelfth day after vaccination. The two cases reported by Fyfe and Fleming (1943) showed thoraco-lumbar girdle pain with meningeal irritation and minimal affect of the pyramidal tract on one side, with clear lumbar fluid under slightly increased pressure and 15 and 35 mononuclear cells per ml. Recovery was complete in nine and eight days respectively. The third case, incompletely recorded, died (Committee on Vaccination Reports, 1928 and 1930). Such cases contrast sharply with the case reported in respect of interval following vaccination, clinical picture and progress.

Neurological complications from tetanus toxoid are practically unknown. Wooling and Rushton (1950) report a case of brachial neuritis following five days after administration of tetanus toxoid.

Neurological sequelæ after T.A.B. inoculation have been classified as syndromes of radiculitis, or plexitis, and mononeuritis, of polyneuritis and Guillain-Barré syndrome, of Landry's paralysis and myelitis, and of cerebral and meningeal forms. Such sequelæ occur most commonly after a second inoculation, usually coming on within fourteen days and most frequently on the third day after inoculation (Miller, 1954). In the case of myelitis described by

Lemke, however, three T.A.B. injections were given in September, 1941, and a further injection in April, 1942. Eight days after this, symptoms of a brachial neuritis commenced which was followed several days after by spread to the cervical spinal cord at the level of the seventh cervical segment. Death followed. In the case reported here, onset was on the fifteenth day after a second dose of T.A.B. vaccine twenty-three days after the first dose. The immediate effect was upon the cervical spinal cord involving the fifth cervical to first thoracic segments with no evidence of cerebral, brain stem or meningeal involvement. There was no further spread. Death did not occur, but recovery was far from complete, there being residual weakness in the muscles of the upper limbs, particularly those innervated from the eighth cervical and first dorsal segment, and slight spastic weakness of the lower limbs.

It is now thought that the pathogenesis of such neurological complications following prophylactic inoculation is that of an anaphylactic reaction affecting blood-vessels (Miller, 1954). Success in treatment of encephalomyelitis following rabies inoculations, where a similar mechanism has been postulated, has been reported with antihistamines (Pickar and Kramer, 1949) and cortisone (Garrison, 1952).

Anti-histamine drugs and cortisone were not used in the case reported here. However, in the light of the above remarks, it is felt that consideration should be given to their immediate use in all cases showing evidence of neurological lesions after prophylactic inoculation, especially where there is evidence of spinal cord involvement.

#### SUMMARY

A case of transverse myelitis following prophylactic T.A.B. inoculation is described. Certain features are briefly discussed.

I wish to record my appreciation to Captain J. A. G. Clarke, R.A.M.C., and Captain A. F. Cross, R.A.M.C., for their constant attention and interest whilst this patient was under their care.

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## NON-SPECIFIC URETHRITIS

BY

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NON-SPECIFIC urethritis is one of the most perplexing conditions encountered in the venereal diseases clinic today. In Britain it was thrown into sharp relief during World War II as those affected in the military hospitals were daily examined for the gonococcus which was found wanting. Although non-specific urethritis had been recognized as an entity for many years, many venereologists still considered it to be a manifestation of gonorrhœa. Its full recognition in the United States came even later and, when it appeared in force amongst the American troops in the Pacific theatre, it was at first believed to be penicillin-resistant gonorrhœa. In 1953, in the clinics of England and Wales, 13,157 cases were treated as compared with 15,242 male cases of gonorrhœa.

The causes of non-gonococcal urethritis are legion. They fall into four main groups :

1. Secondary to external and internal irritants.
2. Secondary to intra-urethral sores and tumours.
3. Secondary to other urethral, bladder and kidney disease.
4. Primary urethritis.

The commonest is a primary urethritis of unknown ætiology.

Before considering these groups in detail it should be recorded that certain conditions may simulate urethritis. Thus in phimotic persons a subpreputial discharge, due to balanitis, primary syphilis, chancroid or condylomata acuminata may lead the patient (and sometimes the doctor) erroneously to believe that a urethritis exists. Similarly, excessive physiological secretions due to prostatorrhœa or spermatorrhœa may bring the patient to the clinic in the belief that he has a urethritis. In the latter condition, usually seen in unmarried young men, the "discharge" comes from the prostate and seminal vesicles. In prostatorrhœa there is a clear sticky glycerine-like discharge, which is most noticeable after defæcation due to pressure of the fæces on the prostate.

### I. URETHRITIS SECONDARY TO EXTERNAL AND INTERNAL IRRITANTS

#### A. EXTERNAL

- (i) *Traumatic*, due to cystoscopy, urethroscopy, passage of a sound, catheterization, urethral syringing, foreign bodies introduced by the patient, urethral calculus, frequent masturbation or excessive coitus.
- (ii) *Chemical* due to injudicious urethral irrigations or insertion of prophylactic material, use of chemical contraceptives, self-infliction, and occasionally following exposure to noxious vapours.

**B. INTERNAL (*Urethritis ab ingestis*)**

- (i) *Crystalluria*, from phosphates, oxalates, sulphonamides, etc.
- (ii) *From irritants excreted by the kidneys*, cantharides, turpentine, potassium iodide, potassium nitrate, phenolphthalein, etc.

*Phosphaturia* is a physiological condition, part of the mechanism of maintaining a constant pH of the blood. Phosphaturia may sometimes produce a milky deposit at the end of the act of micturition which may be mistaken for a urethral discharge. The urine is alkaline and cloudy but clears on the addition of dilute acetic acid. Phosphaturia can be temporarily alleviated by making the urine acid with ammonium chloride 0.5 g. taken three times a day by mouth.

The intake of certain foods, notably strawberries, beetroot, rhubarb, horseradish, cocoa, tea, alcohol, pepper and mustard, have all been reported as occasionally causing a urethral discharge. Most of these foods contain *oxalates* and a "powdered wig" deposit may be noted in the urine resting on a cloud of mucus. Asparagus will produce a urethral discharge in some persons, presumably due to hypersensitivity to methyl mercaptan (asparagine) which is excreted in the urine.

**II. SECONDARY TO URETHRAL SORES AND TUMOURS**

Primary syphilis.  
Chancroid.  
Carcinoma (rare).  
Lymphogranuloma venereum, primary lesion.  
Lymphogranuloma venereum, late lesions.  
Condylomata acuminata.  
Herpes simplex.  
Balanitis xerotica obliterans.

Lesions of most of these conditions are visible at the urinary meatus, but if not can be seen at urethroscopy. The state of the inguinal glands may be very helpful, being typically enlarged in intra-urethral chancre, chancroid and lymphogranuloma venereum, but not enlarged in uncomplicated non-specific urethritis.

**III. SECONDARY TO OTHER CONDITIONS OF URETHRA, BLADDER AND KIDNEYS****A. URETHRA**

Post-gonococcal urethritis.  
Urethral stricture.  
Urethral calculus.

**B. BLADDER.**—Secondary to cystitis from any cause :

*B. coli* cystitis.  
Enlarged prostrate.  
Diverticulum of bladder.  
Stone of the bladder.

Growths of the bladder.  
 Genito-urinary tuberculosis.  
 Abacterial pyuria.  
 Bilharzia (schistosomiasis).  
 Tabes dorsalis.

#### C. KIDNEYS

Stone.  
 Tumours.  
 Pyelitis.  
 Tuberculosis.

*Post-gonococcal urethritis* may be due to slow resolution, secondary infection of the glands of Littre, Cowper or prostate with mixed organisms, to a meatal wart (condyloma acuminatum), urethral stricture, or commonly to a superimposed attack of non-specific urethritis.

Bilharzia (schistosomiasis) caused by the helminth *Schistosoma hæmatobium* should be borne in mind as a possible cause in all countries where bilharzia is endemic. If the other causes listed are not immediately suspect from their history, investigations to exclude them can reasonably be deferred until after the effects of treatment have been noted. In the majority of cases the additional investigations will not prove to be necessary.

#### IV. PRIMARY URETHRITIS

- A. Bacterial.
- B. Abacterial :
  1. Protozoa : Trichomonads.  
Amœbæ.
  2. Metazoa : Flies, fish, flukes and fungi.
  3. Spirochætes.
  4. Pleuropneumonia-like organisms.
  5. Viruses.
  6. Idiopathic.

#### A. BACTERIAL URETHRITIS

Some workers subdivide urethritis into bacterial and abacterial forms according to whether or not visible bacteria are observed in stained smears of the discharges. A large variety of organisms have been incriminated in individual cases, including *Staphylococcus albus*, diptheroids, streptococci (especially *Strep. faecalis*), pneumococci, *H. influenzae*, *B. proteus*, and *Staphylococcus aureus*, Neisseria other than the gonococcus, e.g., *N. sicca*, *N. flava*, etc., diphtheria and tuberculosis bacilli, *Pasteurella*, *Sarcinæ*, *B. crassus*, *M. tetragenus*, etc.

Bacterial urethritis may follow anal or buccal coitus and is said to have a short incubation period of four to eight days. In my own experience the organisms most frequently cultured from the urethra in non-gonococcal urethritis

are *Staph. albus*, diphtheroids, coliforms and occasionally streptococci, enterococci, *Staph. aureus*, *B. proteus* and *Monilia*. The pattern of the urethral flora does not materially change with treatment and similar findings are noted in unaffected controls. While not denying that a true bacterial urethritis can occur, it is personally believed that it is a comparatively uncommon variety of non-gonococcal urethritis.

## B. ABACTERIAL URETHRITIS

### 1. Protozoa

(a) *Trichomonas vaginalis*.—This flagellated protozoon, larger than a pus cell and smaller than an epithelial cell, is found in large numbers of women especially in conjunction with a vaginitis. It has four free flagella at the rounded anterior end and a fifth is reflected back to be attached along the body as an undulating membrane. It has a macronucleus and a micronucleus, and an axostyle at the posterior end with which it can attach itself to cells or debris. *T. vaginalis* can best be seen under the dark field when the motility of its flagella immediately attracts attention.

Other trichomonads, *T. buccalis* and *T. intestinalis*, have been found in the mouth and gut respectively. These differ slightly in morphology, but whether, in suitable circumstances, they can mutate into the vaginal form is not definitely known.

In the woman there may be an intense tender vaginitis with a profuse greenish-yellow frothy discharge. The vaginal walls bleed easily, but milder, more chronic, varieties are not uncommon. The urine can also be shown to contain trichomonads in a number of cases. Spread to the Fallopian tubes and pelvis of the kidney has been reported. It is not known for certain if *T. vaginalis* is the primary cause of the vaginitis or whether it is a secondary invader.

There is no suitable systemic treatment, but the vaginitis can be made to subside with pessaries inserted nightly for three weeks. Acetarsol (Stovarsol, Carbarsone), chloramphenicol, aureomycin or terramycin (each pessary containing 500 mg.), Vagisol (tyrothricin), phenyl mercuric nitrate and allied compounds, Penotrane, Diodoquin, etc., are all useful. Insufflation of these medicaments in powder form is also often successful. In this condition the vagina has lost acidity and lactic acid douches may be helpful. Relapses, unfortunately, are very frequent.

It is obvious that clinicians should try to link trichomonatous vaginitis in females with non-specific urethritis in males. Certainly the more dark-field examinations that are made on urethral discharges of males with urethritis, and the longer the time that is spent on them, the more trichomonads are discovered. Occasionally they may be isolated from the prostate and seminal vesicles. They are found with particular frequency in cases with a purulent discharge in which the gonococcus is surprisingly found wanting. However, an incidence of 10-15 per cent. is all that is usually obtained, and it is impossible, therefore, to incriminate trichomonads as the cause of the majority of cases of non-specific urethritis.

Following treatment of the urethritis with aureomycin or chloramphenicol, the trichomonads may disappear from the urethra or they may persist even after the pus content of the discharge has been largely eliminated. In these cases, and in female cases with bladder infections, it may be helpful to change the reaction of the urine by suitable drugs. Resistant male cases usually ultimately respond to daily urethral irrigations with 1/10,000 oxycyanide of mercury.

(b) *Amœbæ*.—Urethritis may rarely be due to *E. histolytica*, as a complication of amœbic dysentery.

## 2. Metazoa (Flies, Fish, Flukes and Fungi)

A urethritis has been recorded resulting from larvæ of flies and beetles in the urethra, from the entry of certain leeches in Egypt and India, and from the activities of the South American catfish (candyru)—a small fish about 60 mm. in length and 4 mm. wide, which may penetrate the rectum, vagina or urethra of unfortunate bathers—but these are medical curiosities. Nematode worms have also on occasion been passed *per urethram*.

A not infrequent cause of non-specific urethritis, however, in countries in which the disease is endemic is urinary bilharzia. The adult worms of *S. hæmatobium* (the male lies engulfed in the gynæcophoric canal of the female) develop from cercariæ in the liver which migrate to the portal and mesenteric veins to reach the submucous tissues of the bladder, prostate and urethra. Ova with terminal spines are then discharged and these give rise to hæmaturia and cystitis with a secondary urethritis, or directly to a urethritis. The ova develop in fresh water into miricidia which enter the intermediate host—a fresh-water snail of the *Bullinus* species, in the liver of which sporocysts form from which cercariæ are ultimately liberated which penetrate the skin of man to complete the life cycle.

Fungi, too, may occasionally cause a urethritis. Spores and mycelia are then seen in Gram-stained specimens of the urethral discharge. The possibility that these might be contaminants of the staining solutions should be borne in mind. Vaginal thrush due to *Candida albicans* may sometimes be associated with a fungous urethritis in the male. The condition is more common in diabetics.

## 3. Spirochætes

Non-specific spirochætes may be found during dark-field examination of specimens taken from patients with balanitis, fusospirochætosis and secondarily infected sores. Spirochætes resembling *S. dentium* have been noted in centrifuged deposits of urine of patients with *abacterial pyuria*, and neoarsphenamine was once used in its treatment. The claim that such a spirochæte is the cause of non-specific urethritis has from time to time been pressed, but spirochætes are not found sufficiently often to be incriminated as the cause in the majority of cases. When they are found the possibility that they are but secondary invaders is difficult to disprove.

The possibility that urethral spirochætes are related to the practice of buccal

or anal coitus has been considered. Anal coitus, apart from by homosexuals, is utilized in some parts of the world by girls as a means of maintaining "virginity." Anal or buccal coitus is practised in Great Britain, however, no more frequently by patients with non-specific urethritis than by patients with gonorrhœa.

#### 4. *Pleuropneumonia-like organisms*

Pleomorphic intracytoplasmic inclusions, in the form of rings, commas or ovoids, may be seen in scrapings of the urethra staining purple with Giemsa's stain. Sometimes these form morula-like bodies, but their marked pleomorphism distinguishes them from virus inclusions. Pleuropneumonia-like organisms (PPLO) grow readily on nutrient agar or in broth enriched with serum or ascitic fluid, when they form characteristic colonies with an adherent central core. Penicillin is usually incorporated in the medium as a bacterial inhibitor.

As PPLO have been noted in patients with non-specific urethritis, asymptotically in females, and less commonly in controls, they have been claimed as a possible cause of non-specific urethritis by a number of workers.

PPLO have been isolated from man and animals in a wide variety of circumstances, and many organisms apparently may produce "L" forms under certain conditions. Although the possibility that there may be certain pathogenic strains of PPLO cannot be entirely excluded, current opinion is that they are but commensals. (For possible reasons as to their more frequent presence in urethritis cases than in controls—see under Viruses.) Their attempted isolation, as a part of the routine investigations of the venereal diseases clinic, is therefore not at present justified.

#### 5. *Viruses*

Inclusion-like bodies have been demonstrated, lying free or in the cytoplasm of the epithelial cells, in Giemsa-stained urethral scrapings from patients with non-specific urethritis. Similar bodies have been noted in scrapings from the conjunctiva of patients with Reiter's disease and from the skin in keratosis blennorrhagica. These bodies have been claimed as being produced by a virus, PPLO, or by both.

Very similar bodies are seen in such known virus diseases as lymphogranuloma venereum, psittacosis, trachoma, enzootic abortion in ewes and inclusion conjunctivitis—a widely differentiated collection of diseases. The generic term *Chlamydozoaceæ* has been applied to this group of viruses. They are found as uniform elementary bodies 2-3 microns in size, either lying free or in the cytoplasm of the epithelial cells, or occasionally as a crescent surrounding the nucleus. Larger initial bodies may also be found, sometimes indenting a nucleus, which may form colonies of elementary bodies.

Positive proof that non-specific urethritis is commonly due to a virus is lacking, and those who were at one time insistent in pressing the claims of a virus ætiology for the disease now admit that a true virus urethritis is comparatively rare.

During 1951-2 the author was engaged in an attempt to find evidence for or



against a virus causation of non-specific urethritis. Direct attempts to pass the virus into the conjunctiva, joints and urethra of monkeys, the groins of guinea-pigs, the brains and lungs of mice, or into the chorioallantoic membranes of yolk sacs of chick embryos, met with failure. These findings were in accord with those of other workers, although the isolation from a case of Reiter's disease of a filterable agent pathogenic for mice had been claimed.

From an examination of 1,463 Giemsa-stained specimens, which were reported on as to whether blue or red granules or blue or red "colonies" were noted, it soon was apparent that only the blue "colonies" could have any significance. These were found in 34.5 per cent. of 206 cases of non-specific urethritis before treatment, and four weeks after successful treatment the incidence had declined to 5.8 per cent. However, when relapse occurred and retreatment proved necessary, their incidence returned to 30.9 per cent. Moreover in a series of 80 male controls (normal persons, patients suffering from syphilis and non-venereal sores, etc.) they were found in the urethral scrapings of only 2.5 per cent. However, the positive findings were mainly in those patients whose urethrae were *wet* while the urethrae of the controls were *dry*. A further 108 cases of gonorrhœa treated with penicillin were next examined. In these the over-all incidence of blue "colonies" was 14.8 per cent., but two to seven days after the penicillin treatment of gonorrhœa their incidence was as high as 20 per cent., which compared with 27.8 per cent. in the patients with non-specific urethritis at the same time. This difference is scarcely significant. It was therefore concluded that the majority of the bodies seen in the Giemsa-stained scrapings had little to do with non-specific urethritis but rather with inflammatory changes in the urethra. Little benefit is likely to accrue, therefore, from their routine examination in the clinic.

Skin testing with various antigens of viruses of the group of *Chlamydozoacea* have been largely free of cross reactions. Equivocal results have sometimes been reported with Lygranum (lymphogranuloma venereum) antigen. The occasional positive results obtained may be related to the incidence of lymphogranuloma venereum in the community. Psittacosis antigen has in my hands given entirely negative results, although a few positive results were obtained in a small series tested with *cat-scratch antigen*. Further work is required. On the other hand, in large numbers of my patients with non-specific urethritis, tested by complement fixation test to lymphogranuloma venereum and to enzootic abortion in ewes, entirely negative results were obtained, although there was very close agreement in the results of the two tests.

## 6. Idiopathic

One must freely admit that in the general run of cases none of the causes mentioned apparently pertain. Although they must all be borne in mind and excluded as is feasible, the disease non-specific urethritis is clinically an entity with the following features :

It is a venereal disease with a variable incubation period, usually of 4-21 days, although in extreme cases it may be as long as six weeks. The discharge

is thinner and more scanty than that of gonorrhœa and is usually muco-purulent. Sometimes it is watery and much of what was once described as "gleet" or "chronic gonorrhœa" was in fact non-specific urethritis. Occasionally the discharge is profuse and may resemble acute gonorrhœa; frequently it is watery and noted only first thing in the mornings or when the bladder has not been emptied for a long period.

A more or less hazy urine in the first glass is found in about one half of cases, but even in those with profuse discharge the haze is often less obvious than might be expected. There are usually fine threads in the first glass even when the urine is clear. Sometimes both glasses are hazy, indicating a posterior urethritis. There is frequently some mild dysuria which may precede the recognition of the discharge by the patient, while in gonorrhœa the reverse is usually the case.

In the subacute or Waelsch type of urethritis, superficial wedge-shaped excrescences may be observed when the urethra is distended with air under the urethroscope. Later, greyish nodules from the size of a pin's head to a sago grain may give the urethra a cobble-stone appearance. "Urethroscopic stricture" may be noted. The urethroscopic appearance does not seem to be associated with a particular clinical type and there would seem to be no point in performing urethroscopy as a routine.

The disease may be associated with complications of cyctitis, epididymitis, prostatitis and the blood-borne complications of arthritis, conjunctivitis and iritis.

In a study of non-specific urethritis made in British soldiers during the war the sexual habits of patients with non-specific urethritis and various skin complaints were compared. The patients in the urethritis group were more active sexually, as evidenced by their more promiscuous behaviour, their previous higher incidence of venereal disease, and in married men by the greater number of their children in a shorter period of married life. A greater degree of psychological imbalance was also noted in the urethritis group, but this may only have been due to the same factor which led to promiscuity.

The age incidence of non-specific urethritis is similar to that of gonorrhœa, the peak years of incidence being 21-35 years in each. In two civilian series compared at St. Mary's Hospital there was a higher proportion of married men in a non-specific urethritis group than in a gonorrhœa group. Generally speaking, too, there was a tendency for non-specific urethritis to be more common than gonorrhœa in "white collar workers" and gonorrhœa to be more common than non-specific urethritis in manual workers. This observation, however, was possibly only a reflection of marital status.

The somewhat higher incidence of non-gonococcal urethritis (which has sometimes been called "married men's clap") in married men prompts the suggestion that, although it is usually venereally acquired in the male, the female can perhaps become asymptotically infected outside of venery, possibly from the bowel.

Popularly, in the past, non-specific urethritis has often been blamed on

intercourse with a woman too near the period time. It is not possible, however, to reactivate the disease by the injection of blood into the urethra of a recently cured person. The explanation, however, is often a convenient one, as also is "strain" which, although unscientific, certainly reduces penetrating questioning by the patient and uncertain answers by the doctor.

#### MANAGEMENT OF THE INDIVIDUAL CASE

Reducing a plethora of theory into practical procedure, it is usual to deal with a case of non-specific urethritis as follows :

- (a) Ensure that the discharge complained of is of urethral and not sub-preputial origin.
- (b) Ensure that there is actually a discharge. Take a smear and examine the water. The presence of fine threads even in a clear urine will indicate, in the apparent absence of discharge, that the patient's complaint is well-founded.
- (c) Stain the smear with Gram's stain to exclude gonorrhœa. It is of interest to note whether other bacteria are present. The idiopathic urethritis is usually "abacterial" in type. The smear will show pus cells.
- (d) It is useful to examine a specimen of the discharge under the dark-field to exclude trichomonads. The presence of spirochætes can be noted at the same time.
- (e) A blood test should be done to exclude syphilis and a gonococcal complement fixation test to exclude chronic gonorrhœa.
- (f) Appropriate treatment may then be commenced.
- (g) In cases which do not respond, or repeatedly relapse, other investigations such as the examination of a 24-hour specimen to exclude tuberculosis, cystoscopy, urography, etc., should be considered. Bilharzia should at all times be kept in mind in patients in or coming from areas where schistosomiasis is endemic.
- (h) Treatment should be followed by tests of cure and observation to exclude the development of simultaneously acquired syphilis.
- (i) Ideally the consort should always be examined to exclude gonorrhœa, trichomoniasis, thrush or other disease. As the causative organism of non-specific urethritis cannot yet be demonstrated, and many females resent being examined when the doctor cannot give strong reasons for so doing, it is sometimes politic to postpone this until the effects of treatment of the male are assessed. It should be insisted upon if relapse occurs after a return to the same sexual environment.

#### TREATMENT

Sulphonamides, penicillin and streptomycin give only indifferent or fair results, and those obtained with chloramphenicol are little better. Best results are obtained with tetracycline, oxytetracycline and chlortetracycline. The dose

should be a minimum of 250 mg. (one capsule) given four times a day for six days, although better results can be anticipated with two capsules given four times a day for five to six days.

Results of treatment of non-specific urethritis with different antibiotics without other measures have in my hands shown a 63 per cent. cumulative failure rate at three months with sulphonamides, 53 per cent. with both penicillin and streptomycin, 30 per cent. with chloramphenicol in doses of 5-6 g. over five to six days, and 19-25 per cent. with oxytetracycline and chlortetracycline both in the same dosage.

There seems to be some evidence that chlortetracycline and oxytetracycline give best results when they are the first drugs used. It may be cheaper in the long run to use the expensive preparation first with good prospects of cure, rather than try something else and run the risk of inferior results when the expensive drug is finally used.

Cases which fail to the antibiotics or sulphonamides, which may be tried in succession in failing cases, may respond to daily urethral irrigations of 1 : 8,000 potassium permanganate or 1 : 10,000 oxycyanide of mercury.

After treatment the surveillance should be as for gonorrhœa. Clinical and urine examinations should be made and the prostatic secretion examined for pus at increasing intervals of time. It is necessary also to exclude incubating syphilis and it is wise, therefore, to spread these tests over three months, at the end of which time a final blood test should be made to exclude syphilis. The possible dangers of masked syphilis obtain with all of the orally administered antibiotics.

#### MANAGEMENT IN SEAMEN

A urethral smear should be taken before treatment and this should be taken with him when the seaman first attends at hospital. This is the recommended practice on British ships, but it is not always observed.

In ships which carry a doctor it should be possible to have the smears examined for the gonococcus before treating. When no doctor is present the captain cannot be expected to differentiate one type of urethritis from another and the patient will therefore be treated as for gonorrhœa. This means on British ships that he will receive penicillin. The issue of penicillin consists of 300,000 units of procaine penicillin and 100,000 units of crystalline penicillin G, which is then made up in 2 ml. of distilled water. Half a dose is injected intramuscularly. It is recommended that if there is no response that sulphonamides should then be given.

In British ships the sulphonamide supplied is sulphadimidine and the initial dose is eight 0.5 g. tablets followed by four tablets morning, noon and night for four days, to a total of 52 tablets. A pint of water is given with each dose and two to three other pints are taken during the day.

At the intermediate port the smear taken at the onset should be examined. If the treatment has been successful, the first prostatic test may be performed. If time permits to obtain the results before the ship sails, serum tests for syphilis and a gonococcal complement fixation test should also be made.

If the patient still has a discharge following penicillin and sulphadimidine he should be given a course of oxytetracycline, or failing this chlortetracycline, without delay. If these drugs are not available, streptomycin should be given in single doses of 1.0 g. daily for four days.

Patients with blood-borne complications (Reiter's syndrome) are best admitted to hospital and will probably have to be left behind.

At the home port, patients showing resistance to treatment should be thoroughly examined to exclude urinary tuberculosis, bilharzia, trichomoniasis, etc., and should be hospitalized for the purpose if necessary. Those with Reiter's syndrome should likewise be admitted to hospital.

If the treatment has been successful another examination of the prostatic secretion and serum tests for syphilis should be performed. Their future surveillance, with the emphasis on the serum test for syphilis at three months, should be planned.

Cases not found to be showing underlying disease should receive oxytetracycline if they have not already done so, and if this fails they should be given urethral irrigations daily until cured.

#### PROPHYLAXIS OF NON-SPECIFIC URETHRITIS

Short of abstinence, there is no sure prophylactic against non-specific urethritis. The use of a condom combined with prophylactic packet is probably reasonably efficient, although the ointment in the latter can on occasion give rise to a chemical urethritis. Penicillin taken orally or by injection will not prevent it, and it has been noted that the incidence of non-specific urethritis following the treatment of gonorrhœa is little different if the gonorrhœa is treated by penicillin, streptomycin or the tetracycline antibiotics.

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## THE PREVENTION OF VENEREAL DISEASE A SOCIOLOGICAL APPROACH

BY

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IN the review (1) on the "Report on the Health of the Army, 1949-1950," the resistance to any marked decline in the incidence of venereal disease was noted. It was pointed out that during the last half-century the incidence dropped steeply to World War I—incidentally concomitantly with that of alcoholism—and that although, since then, there have been some marked fluctuations, the level has not appreciably altered. "Do we know all the factors involved?" asks your reviewer, and without, perhaps, answering the question, does at least suggest a study of Kinsey. It is therefore to review this evidence that this paper has been written.

The present Army preventive policy (2) is based essentially on an educational one supported by two main premises and on partially optional preventive methods. The first main premise is that in any large group of men there are three sub-groups: (a) Those accustomed to promiscuity, (b) those with little interest in sex, and (c) a much larger group who, although given to much free talk among themselves, have little real experience of matters of sex. The second is that continence is the only sure method of preventing venereal disease infection and that the suppression of the natural sexual instinct is possible without injury to health, and that sublimation can be obtained by concentration on games, general physical fitness, military duties and obligations, literature, hobbies and so on. Yet in spite of this teaching, the incidence in certain theatres\* remains obstinately high, and in fact has always reflected the surrounding civil one. A few years ago it would not have been possible to question these premises, as normal standards of sexual behaviour were not known, but today we have available the report of the Kinsey investigation (3).

Much that is sensational has been written regarding the Kinsey report: that the men investigated were gross extroverts, that the samples were biased and that, anyway, it did not apply to any other country; but that is not the conclusion of considered opinion. Swyer (4) writes: "So valuable is the factual content of these works, that the attempt to summarize their main conclusions has been made. Their universal validity is, of course, out of the question; the sexual mores of different communities vary widely, and it is not, therefore, to be supposed that the behaviour of North Americans is necessarily closely reflected by those of other countries. On the other hand, there are good reasons for supposing that the major tendencies revealed in this study have many applications outside the United States. Some of the statistical results have proved so startling—even to the author—that the extreme care taken to ensure their validity deserves emphasis; indeed, the first 156 pages of the 730-odd

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\* "Report on the Health of the Army, 1951-52" gives the incidence of venereal disease for Korea and Japan as 387 and 262 per 1,000 for the years 1951 and 1952 respectively.

pages of text are devoted to this question, and the means necessary to obtain maximum accuracy. Recent critical scrutiny has given little reason to doubt the correctness of the main conclusions reached."

So let Kinsey (5) speak. He first considers the total sexual outlet for the human male under six heads, those of masturbation, nocturnal emissions, heterosexual petting, heterosexual relations, homosexual relations, and unnatural relations. He finds (6) that the maximum total outlet occurs in the teens when the average figure for the U.S. population is almost exactly 3.4 per week. This rate is reached between adolescence and 20 years of age. He (7) writes that the fact that the unmarried male still manages to find an outlet of 3.4 per week demonstrates the failure of the attempt to impose complete abstinence upon him. The sources of this outlet must be a matter of bewilderment to those who have supposed that most males remained continent until marriage. Nocturnal emissions do not provide any considerable portion of the total outlet, in spite of the fact that many persons have wished that to be the case. Masturbation is a more frequent outlet among the upper social level males where, during the last two or three decades, it has been allowed as a not too immoral substitute for pre-marital relations; but most of the less-educated 85 per cent. of the population (*i.e.*, those not going to college) still consider masturbation neither moral nor normal. For the mass of unmarried boys, nearly three-quarters of the U.S. population (8), heterosexual relations still provide the main outlet. This means that the majority of the males in the sexually most potentially active period of their lives have to accept clandestine or illegal outlets, or to become involved in psychological conflicts in attempting to adjust to reduced outlets. With the data now available, biologists, psychologists, physicians, psychiatrists and sociologists should be enabled to make better analyses of the problem which has heretofore been imposed on this unmarried male in his middle and late teens, and in his twenties. On the attached table (9) will be seen the figures for the incidence of some of the different outlets taken by the various social and educational levels in males of the age-groups 16-26.

Kinsey finds (10) that the total incidence of these outlets for the younger generation is almost identical with that of the older, except that in pre-marital relations there has been a transference from prostitutes to companions and that a larger number of the younger generation is involved at an earlier age in such activities as masturbation, nocturnal emission and petting. He feels that this is largely attributable to the fact that the younger generation of the lower social level is becoming adolescent a year or so sooner due to the all-round improvement in health due to better standards of sanitation, medical care and nutrition.

Kinsey (11) finds that each social level is convinced that its pattern is the best of all patterns; but each level rationalizes its behaviour in its own way. The upper level rationalizes on the basis of what is right or wrong. For this group, all socio-sexual behaviour becomes a moral issue. Morality and sexual morality became more or less synonymous terms. Many persons at this level believe that there are few types of immorality which are more enormous than



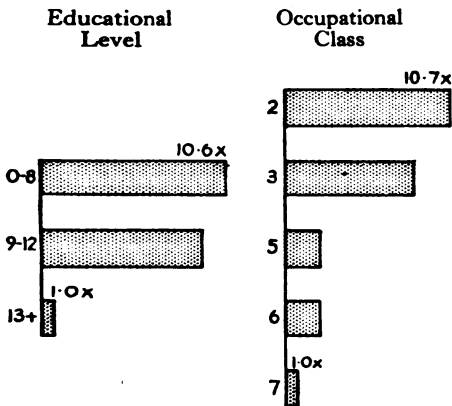
sexual immorality. Proper, straight, upright, honourable, clean, fine, wholesome, manly, and pure refer primarily to abstinence from socio-sexual relations. Their opposites refer to participation in non-marital relations. Honour, fidelity and success in marriage are understood to involve the complete absorption of the individual's sexual urge in relations with his wife. There is nothing of which persons at this level are more afraid than a charge of immorality, as immorality is defined by the group. There is no disgrace that is more feared than that which may result from sexual scandal. Sex is so clearly a moral issue that many persons in the group consider it a religious obligation to impose their code upon all other segments of the population. Lower social levels, on the contrary, rationalize their patterns of sexual behaviour on the basis of what is natural or unnatural. Pre-marital relations are natural, and they are, in consequence, acceptable. Masturbation is not natural, nor is petting as a substitute for heterosexual relations, nor even as a preliminary.

He writes (12) that officers in the armed forces are faced with problems of dealing with persons of diverse social levels who are brought together into a single closely knit community. Since most of the community have not gone beyond the tenth grade in school, most of the men in the armed forces have lower level patterns of behaviour. Some of the officers come out of the ranks and comprehend these patterns. Professionally trained officers who are products of West Point or Annapolis, or some other special school, are more likely to come from better educated levels. Some of the incongruities between the rules of the armed forces and the administration of these rules are products of these differences in the backgrounds of officers and enlisted men. During times of peace, the better educated segments of the population are sufficiently isolated to be unaware of the sexual patterns in the mass of the population. In times of war, when these upper level groups are suddenly thrown into close contact with these other levels, they are startled to discover the realities of sexual behaviour. They are inclined to blame all of the sexual activities which enlisted men have upon the organization of the armed forces themselves. The specific data we have indicate that very few of the men in the armed forces are as active sexually as they would have been at home in times of peace, but the upper level, especially the older generation, is unaware of this. Considerable pressure, in consequence, is brought upon military officials to establish and enforce rules, and upon Congress to enact laws which are designed to force all of the heterogenous group which constitutes a draft army into an upper level pattern of sexual behaviour. The demand is fortified by an emphasis upon the danger of venereal disease; but it is certain that many of the persons who discuss disease are more concerned over the morals of the men for whom the Government has suddenly become responsible. Such an issue could be grasped more intelligently if more people understood the origins of the sexual patterns of the men in uniform.

There is not even evidence (13) that patterns of sexual behaviour are materially altered among men in the armed forces during a period of war. Precise calculation will have to come later, but the available data now indicate

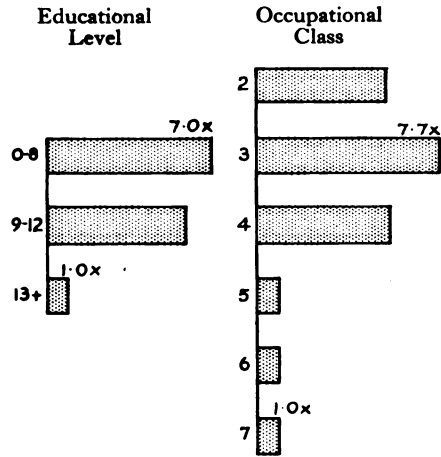
TABLE

## (1) TOTAL PRE-MARITAL RELATIONS



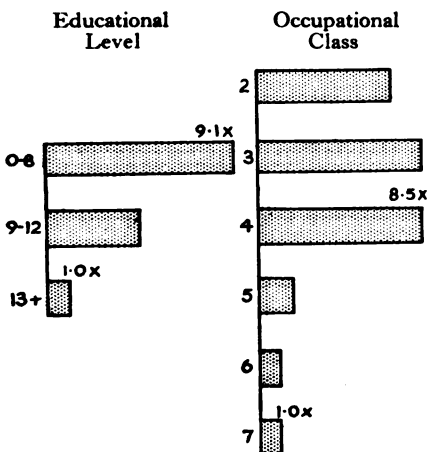
For single males of age group 16-20 relative lengths of bar compare mean frequencies for the group. Note similarity of data based on educational levels and data based on occupational classes.

## (3) TOTAL EXTRA-MARITAL RELATIONS.



For married males of age group 21-25 relative lengths of bar compare mean frequencies for the groups. Note similarity of data based on educational levels and data based on occupational classes.

## (2) PRE-MARITAL RELATIONS WITH PROSTITUTES



For single males of age group 16-20 relative lengths of bar compare mean frequencies for the group. Note similarity of data based on educational levels and data based on occupational classes.

## NOTES

The three American *Educational Levels* represent those of grade and high school and college. They are very roughly the equivalent of the British standards of Primary, Secondary, and University education.

The American *Occupational Classes* are :

0. Dependents.
1. Underworld.
2. Day labour.
3. Semi-skilled labour.
4. Skilled labour.
5. Lower white collar group.
6. Upper white collar group.
7. Professional group.
8. Business executive group.
9. Extremely wealthy group.

On the other hand, the Registrar-General only recognizes five classes, of which the highest (1) is the professional group.

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that it is a small portion of the men who go into the armed forces who materially modify their pattern of behaviour after they leave home. The data are conclusive that such patterns in the case of the male are largely established by the age of 16, and no sort of circumstance, however catastrophic, materially alters them for more than a very few persons in their later years. It is true that many a man has had his first experience in heterosexual relations after he got into the armed forces ; but most of these men would have begun their relations at about that age if they had stayed at home. The men who have the most relations after getting into the armed forces are, for the most part, the men who would have had the most if they had stayed at home. The men who find most of their war-time relations with prostitutes are the men who would have found most of their experience with them at home and the men who avoid prostitutes in the armed forces avoid them for the same reasons that they would have avoided them at home.

As for sublimation (14), Kinsey states that if, from the list of low-rating males, one removes those who are physically incapacitated, natively low in sexual drive, sexually unawakened in their younger years, separated from their normal sources of sexual stimulation, or timid and upset by their suppressions, there are simply no cases which remain as clear-cut examples of sublimation. Whether there is partial sublimation among individuals with higher rates of outlet, it would be much harder to determine. Certain it is that among the many males who have contributed to the present sample, sublimation is so subtle or so rare as to constitute an academic possibility rather than a demonstrated actuality. In view of the widespread and easy acceptance of the theory and the efforts that such a large proportion of the population has made to achieve this goal, one might have expected better evidence of its existence, at least among the sexually least active 5 per cent. of the males in the population.

Although Kinsey is not specifically concerned with the prevention of venereal disease, he does write (15) this : "The meaning of the pre-marital relations will vary with its relation to venereal disease. At the college level, nearly all of the relations are had with a condom. Most of the pre-marital relations are had with girls of the same level. Consequently the incidence of venereal disease acquired by these persons is exceedingly low. On the other hand, the incidence of venereal disease resulting from pre-marital relations at the lower social levels, where condoms are not often used, is as high as and probably higher than is ordinarily indicated in the social hygiene literature."

Now it is necessary to attempt to evaluate these findings in relation to the United Kingdom in the absence of any similar comparable statistical investigation. However, a recent work by Lavers and Seebohm Rowntree (16), the eminent Quaker philanthropist and sociologist, provides interesting confirmatory data. They start their book with a selection from 900 social case histories which they had personally obtained. Although they emphasize that the selection of these case histories was as random as they could make it, they do stress that they are not sufficient to base any accurate statistical significance. However, for what that is worth, the over-all sexual pattern that emerges is

not dissimilar from that presented by Kinsey. In addition, many figures are quoted to give the factual background to English life and leisure. Among the many various figures given are to be found those for alcohol and tobacco consumption per head of population, the incidence of cinema- and church-going and also the number of prostitutes in London, 10,000, of whom 2,000 are estimated in the West End. They suggest that if each prostitute has on an average twenty-five male contacts a week, that would require a total of a quarter of a million male contacts during the same period. They note that in 1939 one bride in every six was pregnant on her wedding day, and we also learn from the C.M.O. (17) to the Ministry of Health that one child in every twenty-one born is illegitimate.

These figures make all one's preconceived ideas topsy-turvy and leave one both flustered and bewildered. Perhaps it is best, in order to look forward clearly, to go back and study first the pattern in the old agrarian society. In it, Alva Myrdal (18) states: "Pre-marital relations may or may not have been exceptional. But there was, however, a structuralized system of mores controlling the meeting and mating of the young within which sexual experimentation could occur. The preliminaries to marriage were fairly well adjusted to that type of society. Youth could be given great relative freedom in playful mating experimentation in this stable society. Such experimentation could be tolerated because it was always 'safe,' meaning that, if relations were involved and if a pregnancy occurred, the male partner was practically always known and marriage followed. In the course of social development industrialization set in. Its effects did not come primarily through a shift in mores but through increased mobility. The breaking up of the stationary life of the village or of the community of the homesteads deprived the existent organization for mating and marrying of one of its primary sanctions. Relations within courtship now involved risks. The migrant labourers, and foremost among them the navvies, the industrial workers, and the commercial travellers, did not have the same respect for local girls as the local men, implying either abstinence from relations or if relations, finally marriage. And the girls did not have at their disposal the impact of the whole society to force men into marriage if relations resulted in issue. Even in the cases where the men could be reached, parents would not look on them with satisfaction unless they possessed land."

Now, perhaps, it is easier to understand the rationale of the strict principles of morality of the last century, and why, as is well known, *pari passu*, a large degree of clandestine prostitution was required to flourish. If, therefore, Kinsey's premises that the total sexual outlet varies little in regard to time or in regard to change in mores, and that the adult pattern is largely fixed in the late teens are accepted, is it not time that, in accordance with these facts, current policy in regard to the prevention of venereal disease should be freshly appraised?

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# LICHEN SIMPLEX CHRONICUS IN CHINESE

BY

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WHILST serving in Hong Kong from 1950 to 1953, I was appointed to a part-time lectureship in dermatology in the University of Hong Kong. While engaged in this work, it quickly became apparent that lichen simplex chronicus (neurodermatitis) was much commoner in Chinese than in Europeans. In 1952 we had the pleasure of a visit from Dr. C. R. Rein, who told us that the condition is also very common among Chinese and other Orientals in America, and kindly provided us with a copy of an article—then in the press—which he had just completed on the subject (Rein and Snider, 1952). In this article, the authors quote Cleveland (1936), who concluded that “the disease occurs more than twice as frequently in Orientals (Chinese and Japanese) as it does in members of the white race.” Apart from these writers, and what is little more than passing reference by Keim (1928) and Fasal (1945), there is scant mention in the literature of what is one of the most striking features of dermatological practice amongst Chinese.

Arnold\* found an incidence of 3.9 per cent in Caucasians as compared with 11 per cent. in a group composed mainly of Orientals. Rees\* found 12.5 per cent. in a group of 750 Chinese dermatological patients.

In the present series, lichen simplex chronicus formed 8.59 per cent. of 1,526 Chinese dermatological cases seen at two out-patient clinics, viz., at Sai Ying Pun Government Hospital, Hong Kong (from December, 1950, to December, 1952), and at a skin clinic financed by the Rotary Club of Kowloon, held in Mongkok, one of the poorer districts of Kowloon, from December, 1951, to June 1952) (see Table I).

TABLE I

	1 Sai Ying Pun Hospital		2 Rotary Club Clinic		Total	
	No.	%	No.	%	No.	%
Lichen simplex chronicus ...	87	9.21	44	7.57	131	8.59
Superficial bacterial infections ...	37	3.90	111	19.10	148	9.69
Scabies ...	41	4.34	182	31.32	223	14.62
Leprosy ...	165	17.46	22	3.78	187	12.26
Fungous diseases ...	61	6.46	21	3.60	82	5.37
Syphilis ...	4	0.42	—	—	4	0.26
All other skin diseases ...	550	58.21	201	34.63	751	49.21
	945	100.00	581	100.00	1,526	100.00

\* Quoted by Rein and Snider (1952).

The first clinic was roughly comparable to a similar clinic in this country, in that all cases had been referred by a doctor, but the figures are weighted by 165 cases of leprosy. (This figure gives a false impression of the incidence of leprosy, and arose because, during the period under review, this clinic was one of the only two places in Hong Kong through which practitioners could dispose of cases of leprosy.) The second clinic was a "charity" clinic, patients being seen directly—as it were "off the street"—and it will be noted that half of the total number of cases is made up by scabies and septic skin conditions. It would therefore appear that neither of these sets of figures is directly comparable with those from skin clinics in Britain or America, and that the true incidence of lichen simplex chronicus among Chinese is probably even higher than these figures, at first sight, might suggest.

The neck was the commonest site, being affected either alone or along with other areas in 49.17 per cent. of cases, and the lower limbs the next most frequent. On the neck, friction by the high collar worn by Chinese women often acts as the "trigger." Also in some cases an allergic contact-type dermatitis arises from the plastic stiffening sometimes inserted into these collars, or from dye or other material used in the manufacture of clothing; and through scratching, a lichenified neurodermatitis becomes superimposed.

In Caucasians, lichen simplex is usually considered to be commoner in females than in males. Ormsby and Montgomery (1948) give the proportion as 2 to 1. In contrast, Rein and Snider (1952) found that most workers agreed that, in Orientals, the disease was either equally distributed between the sexes or only slightly commoner in females. In the present series, the figures from one clinic showed the disease to be only slightly commoner in women (males 43.67 per cent., females 56.32 per cent.), while in the other there was a preponderance of female cases (males 18.18 per cent., females 81.81 per cent.).

The incidence of lichen simplex chronicus in Hong Kong, and that reported by Rein and Snider (1952) and others for Chinese in the United States, differs markedly from that found by workers in China. Tyau (1924), in an analysis of 5,000 skin cases in Shanghai, does not mention the condition. Hu and Yang\* found an incidence of 3.3 per cent. and 4 per cent. respectively, which in no way differs from that in the white population of the United States, namely, 3 to 4 per cent. As Rein and Snider (1952) state, "this is important factual evidence against the theory of any hereditary or constitutional tendency on the part of the Chinese toward development of this disease." In spite of this, however, I believe strongly, for the following reasons, that there is a constitutional tendency for the Chinese to develop this condition.

1. The Chinese, by tradition and upbringing, does not commonly show his feelings, and normally preserves an inscrutable countenance and calm exterior, though within he may be seething with emotion. It therefore may well be that scratching forms an outlet for this emotion.

2. I have observed that Chinese seem to have a lower "threshold" for itching than have Europeans. In a great many cases itching is the principal

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\* Quoted by Rein and Snider (1952).

symptom complained of—to the exclusion of all others. This occurs often in dermatoses, in which in Europeans, itching, though it might be complained of, would not dominate the whole clinical picture. I have also noted that, in many conditions, *e.g.*, contact dermatitis, itching seems to persist longer in Chinese, or at any rate is complained of more volubly. The Chinese have long regarded itching and its relief as sensations to be enjoyed. Chin Shengt'an, writing in the seventeenth century, enumerates thirty-three happy moments, among which he includes: "To keep three or four spots of eczema in a private part of my body and now and then to scald or bathe it with hot water behind closed doors. Ah, is not this happiness?"

3. Maxwell (1929) states: "Perhaps one is struck, on reviewing the whole question of skin diseases in China, with the greater prevalence of the drier skin diseases as compared with the moist"; and this also has been one of my own outstanding impressions. The Chinese seem to develop exudative dermatoses less readily than do Europeans, and intractable weeping eczema is not nearly such a common problem as it is in the white races. A weeping eczema, when it does occur, as a rule dries up quickly with treatment; but lichenification—usually due to scratching—develops readily and frequently. It is therefore usual to find a lichenified neurodermatitis becoming superimposed upon any itching condition, especially the eczemas, scabies, and ringworm; so much so that one comes to regard it as almost the normal outcome. Therefore, taking the broad view of skin disease among Chinese, one cannot fail to be impressed by the fact that the Chinese skin appears to lichenify more readily than the European.

4. Kocsard (1953), commenting on Rein and Snider's article, points out that statistical comparison between clinics in China and America is misleading owing to the much higher incidence of scabies, mycotic and pyogenic dermatoses, and syphilis in clinics frequented by the Chinese poor. (These diseases, he estimates, account for 60 per cent. of cases seen.) The Rotary Club Clinic in this series was comparable to a clinic such as is described by Kocsard, and yet the incidence of lichen simplex was still high. It would, however, be fair to say that the figures at present at our disposal are not really statistically comparable; and I am strongly in agreement with Kocsard when he states that he "would be hesitant to accept as a fact the higher incidence of lichen simplex chronicus in the Chinese living in the U.S.A. as compared with the Chinese living in China."

If, on the other hand, we accept these figures, we must explain why the incidence of the condition in Hong Kong Chinese apparently accords more closely with that in overseas Chinese than with that among Chinese in China. It is of interest to speculate on possible reasons for this. Orens,\* whilst agreeing in general that the disease probably resulted from emotional repression in individuals who, by training and upbringing had been taught always to preserve an impassive exterior, added a number of interesting observations. He gave it as his opinion that the majority of Chinese in America felt discriminated

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\* Quoted by Rein and Snider (1952).



against, and would therefore also, whether they admitted it or not, experience feelings of inferiority. To this he attributed, in part, the high incidence of the disease among Chinese in America. He also stated that, on the whole, Chinese women adjust better to the American way of life than do Chinese men, and that this, along with the fact that "the incidence of sexual difficulties is extremely high among Chinese males both in China and in this country" (America), would explain the equal sex incidence in Chinese, as compared with the female predominance in Caucasians. In Hong Kong, the instability of the political situation, and the presence of large numbers of refugees, with consequent overpopulation and unemployment, would undoubtedly predispose to psychosomatic ailments. Also, there is no doubt that many of the more educated Chinese feel discriminated against, though whether they are, in fact, is a matter of opinion. All of this would explain a high incidence of neurodermatitis among the upper and middle classes. But for the great masses of the working-class population of Hong Kong who, in common with the remainder of the patient toiling millions of China, are by tradition long inured to political instability, to war and famine, to poverty and unrelenting toil, and who care little how they are governed, one would have thought that life goes on much as it has done since time immemorial. Some would argue that, while in the interior of China the poor have a miserable standard of living, by and large each man gets his daily rice and furthermore knows that he will get it, and, having known nothing better, he is content. In Hong Kong, though conditions are probably better, the working man, living alongside the higher standards of living of the western world, not unnaturally expects to have at least certain of these benefits for himself. Therefore, in striving to obtain these on a wage which will not support them, and under conditions where overcrowding and unemployment are prevalent, he finds life more difficult than does his brother in China. This argument, however, is not entirely convincing.

As regards a feeling of inferiority, this is the last thing the Chinese naturally possess, for no nation in the world—with the possible exception of the English—has a greater national conceit. The very name of China—Chung Kwok (the Central Country)—at once dispels any thought of racial inferiority. Orens\* states that "most people who experience actual discrimination do show some feeling of inferiority"; and, as already stated, many Chinese in Hong Kong probably do feel discriminated against, and may therefore have feelings of inferiority, though they would be the last to admit to them.

In conclusion, I would record it as my opinion that, when sets of figures for lichen simplex chronicus, which are strictly comparable as between China and the West, are eventually obtained, the incidence in China will be shown to be significantly higher.

#### SUMMARY

1. A high incidence of lichen simplex chronicus (neurodermatitis) among Chinese is reported from Hong Kong.

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\* Quoted by Rein and Snider (1952)

2. American writers have drawn attention to a similar high incidence among Chinese and other Orientals in the U.S.A. ; but reports from China proper would suggest that the condition is no commoner there than in the white population of Britain and U.S.A.

3. The writer believes that there is an inherent constitutional tendency for the Chinese to develop this condition, and he suggests that the figures from the interior of China may be misleading owing to the fact that skin clinics in China are not directly comparable to those in the West. The reasons for these views are elaborated and discussed.

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## “MEDICAL AVERNUS” D.G.A.M.S. Exercise, 1954

BY

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It is rather a relief to know that it will not be my job to rake over the rubbish-heap of a long lost classical education for a title for the next D.G.'s exercise. It has become almost traditional to give to military exercises titles which hint that the more senior officers have had the benefit of a grounding in what the Scots call “the humanities”—a grounding received, of course, at a time when they were least able to enjoy it; in fact, as I said of Xenophon's *Anabasis* in my account of our 1952 exercise, “at a time when the sufferings, dissensions and glories of the immortal Ten Thousand were merely a boring recital of stades and parasangs.” Now we have all heard of the N.C.O. who told the soldier that only officers had abdomens—the men have stomachs; and a ripe old specimen of a senior officer once said: “Officers are never drunk, sir. The men get drunk—officers become flushed with wine.” But I think we can take it as axiomatic that, in these democratic days when a vigilant press is liable to comment on our every action, senior officers are *never* snobs. Nevertheless they may feel that, however inaccessibly filed in the archives of the memory, a classical education confers a tenuous cultural superiority over those whose education seems to have led to a preference for horror comics. (Has the editor ever considered if the circulation of this Journal could be stimulated by introducing a supplement to appeal to that class of reader? The directorate of pathology can always provide plenty of A.B.C. horrors, though it would be irreverent to suggest that it can be comic—not that this stopped me from hinting just that in this Journal in my account of the 1951 exercise.) For our 1954 title we toyed with many possibilities. To mention only two which we rejected: “Phœnix”—there might not be much rising from the ashes of an atomic explosion; and “Pompeii”—no use; it took over two thousand years to evacuate the casualties. So “Avernus” it was, and for no one more than for medical services would another war be the gateway to hell.

In 1951 in “Medical Mushroom” we made a very detailed survey of many of the medical aspects of A, B, and C warfare. The demonstration of protection from atomic explosions staged by Colonel D. M. Ahern became a classic, and has been repeated in various forms to many audiences by the Field Training School and others. We did not then deal with the problems of planning and deployment with which the use of atomic weapons would confront the medical services. We should probably try to stop talking of atomic warfare, since all war must now be atomic war; and of course the implications of these weapons have been examined at every exercise for some time now. The D.G. thought

that the time had come to state these implications as realistically as possible without understatement or exaggeration. As an example of our British gift for understatement I will quote Sergeant William Lawrence of the 40th Foot, who described the fate of a comrade who "was struck dead, his shirt being burnt in places like tinder, and his mess-tin turned black" when struck by lightning, as an "inconvenient mishap to a soldier" (1). This can perhaps be equalled only by the Indian gaoler who was asked why a prisoner looked gloomy and replied, "Sir, he is to be hanged tomorrow, therefore he is somewhat peevish."

There is less likelihood of underestimation of our dangers than of a tendency to unbalanced exaggeration of the horrors with which we may be faced. Only some 15 per cent. of the survivors in Hiroshima and Nagasaki suffered effects of ionizing radiation, yet there are signs that this is the effect of atomic explosions most feared by the public. I once heard a young soldier speak of the "atom ray" as if it were the death ray of science fiction. Devastating though the blast wave of the atom bomb may be, it is not a sharp blow like that of the blast from conventional weapons but a sustained push; and, whilst it affects many strong structures like a combined cyclone and earthquake, the human body, unless flung against hard surfaces or struck by flying debris, may well escape serious effects like the ruptured organs and eardrums caused by other types of blast. Obviously the heavy casualties and the high proportion of burns would throw a severe strain on the medical services and call for a high degree of flexibility in our plans and in the working methods of units, but it may be well to remember that, although we who know only the last war have seen no really heavy casualties, our fathers and forefathers have seen horrors far worse than even atomic attack should inflict upon well-trained troops, and the British Army has survived them. Napier (2) tells us that at the Nive 5,000 men fell in one hour in a space one square mile, and Captain Gronow writes of the Grenadier square at Waterloo, that "it was impossible to move a yard without treading on a wounded comrade or upon the bodies of the dead" (3). Yet a soldier of the 71st Regiment, after a graphic account of the "horrible spectacle," adds: "I looked over the field of Waterloo as a matter of course—a matter of small concern." (4) Flash burns they may not have known, but in the summer Peninsular battlefields often caught fire. The sufferings which resulted from this have been described by Rifleman Costello at Talavera (5) and at Vimiera by Sergeant Robertson, who saw the battlefield six days after the battle, when it was still "strewed with the dead and some of the poor wounded fellows were still living . . . and the wounded who were unable to drag themselves out of the way of the flames, as well as the dead bodies, were scorched in a horrible manner" (6). One could quote many similar descriptions from the spate of journals and memoirs with which Wellington's men started the fashion of war-time reminiscence.

The term "The Great War," which to us for so long meant 1914-1918, is used for the Peninsular War by writers such as Oman and Fortescue in books published before 1914, yet Colonel G. F. R. Henderson says that the casualties on both sides at Gettysburg and the Wilderness equalled the casualties in the

British Army for the whole Peninsular War plus Quatre Bras and Waterloo (7). The D.G. told us at "Rubicon" that when he was a young R.M.O. in the Somme battle, the 29th Division, with thirteen battalions in the line, sustained 6,000 casualties, which were evacuated from the battlefield in forty-eight hours. At a 43rd Division medical exercise Colonel Lytle, the A.D.M.S., quoted some similar figures, including the total losses of the 8th Division in four years, which were 2,927 officers and 60,931 other ranks. In the Somme battle 26th Field Ambulance rarely handled less than 1,000 casualties each day, and on one occasion this unit itself lost 41 bearers out of a total of 90. Volume III of the Medical Services General History gives figures for the other two field ambulances for this division for the first three days of the battle. The total admissions were 3,056. Total evacuations : walking cases, 836=27.9 per cent. ; lying and sitting, 2,166=72.1 per cent. These figures Colonel Lytle, who like myself knew only World War II, said he finds "quite horrifying"—yet Sir Winston Churchill in his *Life of Marlborough* says : "The spectacle of one of the battlefields of Marlborough, Frederick, or Napoleon was incomparably more gruesome than any equal sector of the recent fronts in France or Flanders" (8).

The eye-witness accounts I have mentioned are almost unbearably moving, but none more so than Sir Winston Churchill's descriptions of Marlborough's battlefields. "Sometimes two hundred thousand men fought for an afternoon in a space no larger than the London parks put together and left the ground literally carpeted with a quarter of their number, and in places heaped with maimed or slaughtered men. . . . In prolonged severe fighting the survivors of a regiment often stood for hours knee-deep in the bodies of their comrades, writhing or for ever still. In their ears rang the hideous chorus of the shrieks and groans of a pain which no anæsthetic would ever soothe" (8). No apology could be needed for quoting such words, and I make none for this lengthy preamble to my account of "Avernus," for I am sure that it is important that our apprehensions of the fearful possibilities of any future warfare should be balanced by realization of what the British Army has endured—and even gloried in. We must capture and instil into our soldiers the spirit which sustained their ancestors. Some hints as to how we might do this would surely be our chief reward if we were to follow Napoleon's advice to read and read again the campaigns of the great captains. But, whether or not Napoleon would allow any of the World War I generals to fall in in the ranks of his great captains, there may be rewards of a more concrete sort awaiting the man who will study the casualty figures of some of their hardest fights, and how the medical services dealt with the wounded. After all, their units were not so very different from ours, and some such research, especially if it could include reliable opinions from those who served in their field ambulances and C.C.Ss., should surely be a most valuable guide in any reorganization of our methods in the field to cope with an expected increase in battle casualties. If any keen historian undertakes this task I hope that he will send me a copy of his conclusions.

This long and not-so-easy descent to Avernus has at last arrived at the exercise, which began with an authoritative survey of recent developments

in atomic warfare by Mr. Neville Gadsby of the Army Operational Research Group.

The story of our exercise grew out of a winter study period conducted by the D.G., and dealt with a force of half a million men in "Mythland," an imaginary continental country, and particularly with the problems caused by attacks with many atomic weapons in addition to heavy fighting. If a regular attendee at our exercises woke up in World War III and found that Colonel John Crosse was not the Army Group D.M.S. he would know it was only a dream, and go to sleep again. We knew it was pretty hopeless to disguise him, but decided to try the effect of a bald head—a condition caused, I am reliably informed, by an excess of male hormones. What his hormones had failed to do for him was achieved by Captain Alan Critchley, and our D.M.S. presented a pickled walrus face topped by a fine specimen of the stately domes of England. His appearance was the only comic aspect of the sixty-five minutes during which he gave a masterly survey of his medical plan which was deceptively lucid and easy to listen to, and accordingly involved a lot of hard work. This was followed by a talk by Lieut.-Colonel Marks on casualty estimation, which included a demonstration of a device elaborated by Mr. Gadsby, with which an A.D.M.S. or D.D.M.S., who knows the location of ground zero of an atomic explosion and has the deployment of troops in the affected area marked on his map, can make a quick estimate of his problem, and so make a tentative plan before information is received from reconnaissances made at the scene of the attack. We then went on to D+8 and heard the story of the opening days of the war which began with heavy atom bombing of ports, cities and industrial areas in "Mythland" and in the U.K.; and, as we heard later, even heavier attacks by us on the Fantasians, our traditional exercise enemy. This playlet was set in the office of the D.D.M.S. of the Army Group, and opened with a broadcast from London in a warm transatlantic voice suggestive of Alistair Cooke in his best form, but actually supplied by Captain "Matt" Cooper, who has replaced Captain O'Brecht as our Canadian member of the Field Training School.

To give a comprehensive picture of the workings of Civil Defence was a formidable task capably performed by Lieut.-Colonel Maitland and a team of assistants, with an enormous and elaborate model of a city and its suburbs, of which W.O.II H. N. Evans, R.E., of the Army School of Health, and his carpenters were justly proud.

The object of the last serial of the first day was to select three syndicates and to give them the problems which they had to study. This was done in a playlet which gave Colonel Crosse a fine chance to let himself go in a hilarious act with Captain Critchley, who had invented and constructed a machine to which justice could be done only by an illustration by Heath Robinson or Emmett. This was exhibited and duly selected the syndicates; and made a good job of it, too, because these syndicates under Colonels Furnival, Oxley, and Ollerenshaw produced solutions completely different from one another and from the solution of the directing staff. These were presented and discussed on the

second morning, after which we had most interesting lectures, on Resuscitation by Lieut.-Colonel Stephen, and on Burns by Mr. Patrick Clarkson, who very kindly stayed on until the evening to take part in a discussion. He is very generous with his time where our army exercises are concerned, and I have now heard him speak at four, and am still astounded at what a lot he manages to tell us in the all too short time which is usually available.

On the second afternoon the Field Training Centre staged a demonstration of the effect of an atom bomb over part of an Army Maintenance Area, in which 550 men took part. It began with a report by R.T. describing the approach of a formation of enemy aircraft apparently on its way to attack a nearby city. One was seen to break away from the formation and soon afterwards a well-simulated "atom bomb explosion" was seen. It was a low airburst, probably designed to cause embarrassment by contamination of ground rather than casualties. But at the first stand we saw that Fantasian luck was in, as a big pay parade had been formed up in the open facing the ball of fire and a great number were suffering from flash burns and shock. Time was now telescoped and we saw the first efforts to organize first aid and self-help; then the arrival of the C.O. of the army field ambulance to reconnoitre and decide on how best to deploy his unit; the approach of monitoring teams reporting to their H.Q. by "walkie-talkie"; and the arrival of the company of the field ambulance, which quickly set up a treatment centre near the R.A.P. of the R.H.U. Next we walked round the scene, and then went to a nearby C.C.S. which had been partly affected by the bomb.

A demonstration must be well rehearsed if it is to retain the interest of senior officers, most of whom have already seen rather too much of this sort of thing. Some are renewing old acquaintances, and as they are herded, or perhaps one should say marshalled, from stand to stand it is evident that they would greatly prefer to go on reminiscing about old so-and-so, or 'Pindi in '32. Some are buoyed up by the prospect of seeing some really humorous hitch, like the old gentleman who went to church only once a year—on Christmas Day, in the hope of hearing the choir break down in the anthem. I once saw this type display rather less than enjoyment when the hitch did occur. They had declined to be issued with gas-capes and to offer themselves as targets for an air attack with mustard substitute. The aircraft sprayed the wrong party and they went home with their neatly pressed drill or gaberdine looking like a typhus rash. The Field Training Centre deserved special praise for the absence of boredom or hitches because it was not possible to rehearse their demonstration in detail, since such large numbers of R.A.M.C. men, who included reservists, could not be diverted from their normal duties for more than three days.

When planning "Avernus" we were determined to avoid the now familiar features of most exercises dealing with atomic weapons—the scientific discourse on nuclear fission; the films and pictures of Hiroshima and Nagasaki, which after all are now nearly ten years old. But in a delightful lecture Colonel Meneces brought to life the tale of those two cities, and explained certain aspects of their fate which have a direct bearing on our training today. I believe he may live

to regret his brilliant performance because, although the script of his lecture can be read in the exercise report, its value is greatly increased by his beautiful slides and his own explanation of them, and I foresee many requests for the lecture at other exercises.

On the last morning further corps problems and divisional problems were presented and discussed. Altogether during the exercise some three hours were spent in very profitable discussions, and the opinions expressed are now being examined at the War Office.

On the last morning of the two previous exercises an hour was given to discussion of A.E.R. and T.A. problems. This year I reviewed the progress in their training which has been made in the past three years ; and some remarkable progress has been made. The present conditions of national service make it essential that a man's training should be actively continued, and indeed in many cases its deficiencies remedied, during his reserve service. During the past three years, which have seen the organization in its present form of the Army Emergency Reserve, there has been a notable growth of co-operation, and I think it might be said some intensification of mutual esteem, between the medical services of the active and reserve armies. We are indeed all one medical service, and one manifestation of this has been the very great increase in the numbers of medical officers of the reserve army invited by the D.G. to attend his exercises. The number of reservists under training and the nature of their training will probably surprise many who are not actively concerned with the reserve army if they read this part of the exercise report.

We were glad to have with us for the whole of the exercise representatives of the Royal Navy and Royal Air Force. Major-General Dimond represented the Home Office, and Colonel Morgan Smith represented the D.M.S. of the Canadian Army, with three senior officers of the R.C.A.M.C. Lieut.-Colonel Bhalla, now with the High Commissioner for India in London, attended ; and the United States of America were represented by Brigadier-General Wilfred Hall, the Chief of the Medical Branch at SHAPE, and of course our old friend Colonel Walter Moursund, who always accuses me of having once begun some remarks with "Ladies and Gentlemen—and Walter Moursund." If I ever did this it would have been perfectly understood by any officer who has attended many conferences with him, for his contributions to discussions are always pithy and to the point, and delivered in characteristic style and with dry Kansas humour which helps to fix them in one's memory. As this will be his last D.G.'s exercise he made some very kind remarks on the last day, from which we were happy to learn that he has enjoyed being with us as much as we have enjoyed having him. Needless to say, the contributions of these distinguished visitors to our discussions greatly enhances their value.

Once again the D.G. in his closing address thanked those whose hard work had made the exercise a success—a very pleasant thing to hear, but, as he well knows, quite unnecessary, because the hard work is always more than cancelled out by the fun. Throughout the year the D.G. himself is always ready to escape from the cares of his high office for a frolic with the Fantasia and the Myth-



landers. As the day draws near and final rehearsals begin, his enthusiasm, and perennial conviction that this year's exercise is going to be the best we've ever had, keep us all going. "Compulsory overtime" is not in the Field Training Centre vocabulary. I'm bound to say that I feel a bit sad that next year's changing-room pep-talk will be given to a team with a new centre-forward—or in view of the D.G.'s noted weakness for cricket (which as a Scot I regard as an organized waste of time), should I compare the Inspector of Training rather to a wicket-keeper who has to stop all the fast balls bowled by the captain?

It is hardly necessary to wish my successor joy, for it is always a joy to work with the Field Training School; and to have introduced so many of their demonstrations, the fame of which has spread beyond R.A.M.C. circles, has been like leading in endless winners which one had neither bred nor trained—a lovely life. Now they are part of our new Field Training Centre; the principal meeting-place between the medical services of the active and the reserve armies as they go forward together to a state of efficiency which could be a powerful prop to the morale of the Army and of the nation should they ever be called upon to face the trials which were studied during Exercise "Medical Avernus."

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# CULTIVATION OF MYCOBACTERIUM TUBERCULOSIS

BY

Colonel L. R. S. MACFARLANE, O.B.E., M.D., D.P.H.

Captain D. MORGAN, M.R.C.S., L.R.C.P. R.A.M.C.

and

Mr. D. GOODE, A.I.M.L.T.

A REPORT by a working party of the Public Health Laboratory Service on the laboratory diagnosis of tuberculosis, reported in the Monthly Bulletin of the Ministry of Health and Public Health Laboratory Service (August, 1952, Vol. 11, p. 187 onwards) and referred to in the *Bulletin of Hygiene* (September, 1953, 28, 748), lays out the best methods of homogenization of sputa prior to culture on Lowenstein-Jensen medium and places in the following order four methods :

- (1) 3 per cent. Sulphuric acid,
- (2) 4 per cent. Sodium hydroxide,
- (3) Jungmann's,
- (4) Trisodium phosphate.

The second part of this report suggested that the heat evolved by thirty minutes' centrifuging exerted a deleterious effect on *M. tuberculosis* over that which could be exerted over a period of fifteen minutes and recommended the latter period for all such procedures. Anderson, Hughes and Knox, writing in the *J. Clin. Path.* (1953, vol. 6, 2, 124-7), suggested that the low grading of Jungmann's method was due to a departure from the original method of Jungmann by the workers embodied in the working party's report. They stated that the "3% hydrogen peroxide" given in the original paper had been misinterpreted and that in effect one-tenth of the amount of  $H_2O_2$  required had been used.

They recommended 3 ml. of 10 vol.  $H_2O_2$  for good results. They also recommended considerable other alterations to the method laid down by the working party.

We therefore decided to try out these conflicting statements both at the Royal Army Medical College and the Connaught Military Hospital Laboratory, and also to test the results of the two periods of centrifuging. We arranged therefore to test as follows :

200 specimens by the Petroff method trying both rates of centrifuging.

200 specimens by the Jungmann method trying both rates of centrifuging.

In these latter 200 cases the Connaught Laboratory used the 3 ml. of 10 vol.  $H_2O_2$  and the Royal Army Medical College the method used by the working party, *i.e.*, one-tenth of this.

Specimens selected were divided into :

- (a) those from cases originally sputum positive now sputum negative, and
- (b) from cases still sputum positive.

Ten cases were investigated a week, each sputum specimen being divided into two, one-half being examined by the Royal Army Medical College and the other half by the Connaught Laboratory.

The Petroff method used by both laboratories was as follows : The specimen of sputum was mixed with an equal volume of 4 per cent. sodium hydroxide and allowed to stand for thirty minutes until digestion was completed. Phenol red indicator was then added. Incubation was only performed if the sputum was particularly viscous.

Equal quantities of the mixture were centrifuged at fifteen and thirty minutes respectively at 3,000 r.p.m. The deposit was neutralized by 8 per cent. hydrochloric acid and the supernatant discarded into lysol.

Both the fifteen- and thirty-minute deposits were then inoculated on to two Lowenstein-Jensen slopes each and incubated for six weeks at 37° C.

Both unconcentrated and concentrated sputa were checked by Ziehl-Neelsen staining.

The Jungmann method used was to add to a measured quantity of sputum 0.6 of its volume of each of Solutions A and B. The container was then shaken and divided into two further universal containers for the different centrifuging periods : after the first centrifuging the supernatants were discarded, and the volume adjusted with sterile saline solution up to the neck of the container and a second centrifuging done—both at 3,000 r.p.m.

Plating on Lowenstein-Jensen slopes and incubation were carried out as before.

Solution A=Ferrous sulphate, 20 grammes.

Concentrated sulphuric acid, 20 ml.

Aqua dist., 180 ml.

Solution B=Hydrogen peroxide (made up fresh for use).

10 volumes (Connaught).

20 volumes of 5/100 (R.A.M. College).

## RESULTS

### *Royal Army Medical College*

*Petroff Method.*—Of the 200 cases tested, of which 114 (57 per cent.) were eventually found sputum positive by direct staining, culture by this method showed positive :

In 128 by the fifteen-minute technique, and

In 125 by the thirty-minute technique (67 and 65 per cent. respectively),  
i.e., a very slight swing in favour of the fifteen-minute centrifuging.

*The Jungmann Method.*—Of the 200 cases tested, again 114 (57 per cent.) were positive eventually by sputum staining. Of these cases, however, only

65 were positive on culture after thirty minutes' centrifuging and 80 after fifteen minutes' centrifuging (35 and 42 per cent.).

This suggested that the low category for the Jungmann method by the working party was *upheld* and that, at any rate with this method, the fifteen minutes' centrifuging was an advantage.

### *The Connaught Laboratory*

*Petroff Method.*—This laboratory only succeeded in finding 100/200 sputa ultimately positive by staining (50 per cent.).

Of these 200, 115 (57 per cent.) were found positive on culture after fifteen minutes' centrifuging and 117 (58 per cent.) after thirty minutes' centrifuging. The difference of 1 per cent. is not worth considering.

*Jungmann Method* (using neat  $H_2O_2$ ).—Again only 100/200 sputa were finally found positive by staining. Of these 200, only 69 (34.5 per cent.) were found positive on culture after fifteen minutes' centrifuging and only 7 (3.5 per cent.) after thirty minutes' centrifuging (excluding doubtful positives and interference by debris in the inoculum by this method).

Again the difference of centrifuging time has greatly improved the picture. The over-all picture with the strong  $H_2O_2$  is, however, very unsatisfactory.

It would appear, therefore, that the shorter time of centrifuging is of advantage only in certain methods of homogenization, apparently in the more inferior methods.

### SUMMARY

An attempt has been made to define the relative values of Jungmann's and other methods of homogenization in the culture of *M. tuberculosis* from sputum, in consideration of comments on the report of the working party of the Public Health Laboratory Service, on the Laboratory Diagnosis of Tuberculosis (Monthly Bulletin of Ministry of Health and Public Health Laboratory Service, August 1952, Vol. 11) which appeared in the *Journal of Clinical Pathology*, 1953, Vol. 6, 124-7.

An attempt has also been made to evaluate the claim that fifteen minutes' centrifuging is superior to thirty minutes', made in the same working party report.

This work was undertaken by the Pathology Department of the Royal Army Medical College and the laboratory of the Connaught Military Hospital.

Two hundred cases were investigated by each laboratory by the Petroff homogenization method and 200 by the Jungmann method, in which latter method the Connaught Laboratory used ten times stronger  $H_2O_2$  as suggested by Anderson, Hughes and Knox. All sputa were spun both for the fifteen- and thirty-minute periods.

Of these 400 sputa, approximately 200 were positive by staining, but *all* patients had originally been positive.

It was found that by the Petroff method the difference in successful culture

between the two centrifuging periods was negligible, but that using both methods of Jungmann the fifteen minutes' centrifuging had a distinct advantage—particularly so where the stronger  $H_2O_2$  was used.

As regards the value of the methods, we cannot but agree that Jungmann's method is by no means the best—and that with the higher strength  $H_2O_2$  it is even less efficacious.

#### CONCLUSIONS

A trial of Jungmann's homogenization method for culture of *M. tuberculosis* was carried out alongside Petroff's method by two laboratories. All specimens received two types of centrifuging, one for fifteen minutes and one for thirty minutes.

It was found that there is no difference worthy of note between the results from the two periods of centrifuging, *provided* a reliable homogenization method was used.

Jungmann's method did not prove reliable in our hands, but was definitely improved by limiting the centrifuging to fifteen minutes, *i.e.*, the effect of the prolonged centrifuging may well be on the homogenization mixture rather than on the bacteria.

# TONSILLITIS AND SPLENOMEGALY

BY

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TONSILLITIS is a common disease among people of both sexes and all ages, and it is commonly regarded as a mundane, rather trivial illness. It is especially common amongst troops, being in close contact with each other in tent or barrack accommodation.

During the winter months from November, 1953, to April, 1954, 185 cases of tonsillitis amongst British soldiers and their wives were admitted for treatment to this hospital—the largest of several in the Canal Zone. Of these, 19 men and one woman were found to have degrees of splenomegaly easily detected by ordinary routine palpation—an incidence of over 10 per cent. The splenomegaly was in all cases checked by at least one and usually two independent observers. Sixteen of the men were under the care of one of us (P. G. C.), while the remainder were kindly referred by colleagues for inclusion in this series.

## CLINICAL FINDINGS

The principal clinical findings are summarized in Table I.

The degree of splenic enlargement varied from the just definitely palpable to the moderately enlarged, palpable two to three fingers' breadth below the costal margin.

According to Wintrobe a palpable spleen is not necessarily enlarged, though it is usually taught in this country that if the spleen can be felt at all, it must be enlarged, unless it is displaced. In the present series, the fact that the splenomegaly developed and declined *pari passu* with the tonsillitis would make any but a casual relationship unlikely.

It must be remembered that in a tropical climate an enlarged spleen is perhaps more conscientiously searched for than in a temperate area.

Only in five cases was there adenopathy apart from tonsillar adenitis; the glands involved were in one or both posterior triangles, but the glands were small and their significance was doubtful.

Seven of the patients had had jaundice in the past, and one (possibly two) had had malaria—both diseases known to cause an enlarged spleen at some stage in the disease.

## INVESTIGATIONS

It was hoped to prove that the splenomegaly was, or was not, due to glandular fever by doing a white cell count and a blood film examination about once a week for four to six weeks together with two or three Paul-Bunnell reactions. However, owing to transport difficulties and frequent movement of troops, this ideal could not always be attained.

The white cell count in nearly all cases showed an initial polymorphonuclear leukocytosis, but later in most cases developed no special characteristics. In a few patients there was an absolute lymphocytosis at some stage. In no case were abnormal lymphocytes seen in significant numbers, although only 72 per cent. of the films were specifically examined for atypical cells. In cases 5, 8 and 18 a few of the lymphocytes appeared suggestive of those seen in glandular fever, but they were less than 1 per cent. of the differential count.

The Paul-Bunnell reaction was negative in every case with no agglutination above a serum dilution of 1 : 10, except for the second and third specimens of serum from case 2, collected on the 33rd and 80th days after the onset of the sore throat, when the titre was 1 : 80, and the second specimen, collected on the 11th day, from case 20 when the titre was 1 : 40. Unfortunately absorption with guinea-pig kidney and ox cells could not be performed.

Throat swabs were taken in six cases and *β-hæmolytic streptococci* were grown from five ; in the sixth, Vincent's organisms were seen on the direct smear.

Blood cultures in six cases were sterile.

The erythrocyte sedimentation rates (E.S.R.) in two cases showed a moderate rise.

The sternal marrow examined during the first admission of case 11 was normal.

## TREATMENT

Apart from gargles three times a day and intramuscular penicillin for four or five days, no treatment was given and the results were satisfactory.

## DISCUSSION

The clinical picture of tonsillitis, splenomegaly, and in a few cases cervical lymphadenopathy, is rather suggestive of the anginose type of glandular fever, but we feel that these cases are not this condition. Clinically the response to treatment is too rapid, and during the period covered by this series there were only three cases of glandular fever admitted to this hospital. Pathologically the Paul-Bunnell titre does not rise high enough to be significant, nor are there enough Downey cells of any type on which to make a diagnosis of glandular fever. The culturing of *β-hæmolytic streptococci* from five out of six cases is more indicative of this condition being a primary tonsillar infection rather than glandular fever in which the tonsils appear to become secondarily invaded with Vincent's organisms.

The age and sex distribution, though similar to that of the sporadic form

TABLE I

Case No.	Age	Sex	Duration of sore throat before admission (days)	Previous attacks of tonsillitis.	Past history J = jaundice M = malaria R = rheumatic fever	Severity of tonsillitis	Duration of splenomegaly in days after admission	Degree of splenomegaly
*1	19	M.	3	Nil	J aet 18	A	3	2
2	18	M.	1	?	Nil	A	2	2
3	22	M.	2	1	Nil	A	3	3
4	20	M.	2	Nil	Nil	B	2	1
5	19	M.	2	1	J aet 14	A	3	2
*6	30	M.	3	3	M and J aet 20	B	3	1
*7	19	M.	3	Nil	Nil	A	2	2
8	19	M.	3	Nil	Nil	A	8	2
9	21	M.	2	Nil	Nil	C	5	2
10	19	M.	2	Nil	J aet ?	A	2	2
			2	Nil		A	14	3
11	22	M.	{ 1	1	Nil	A	8	3
			2	2		A	5	3
12	20	M.	2	Nil	Nil	A	3	2
13	18	M.	2	5	Nil	A	2	1
14	19	M.	1	Nil	J aet 9	A	6	2
15	22	M.	3	12	? M aet 21	C	5	3
16	18	M.	2	Nil	Nil	A	2	2
17	20	M.	3	Nil	J aet 12	C	5	2
18	22	M.	1	Nil	Nil	C	2	2
*19	35	F.	2	Nil	{ J aet 12	A	4	3
					{ R aet 16			
20	22	M.	2	1	Nil	A	7	2

## LEGEND TO TABLE I

Grades of tonsillitis : A—Tonsillar enlargement (frequently gross) with many purulent follicular exudates and tender tonsillar glands.  
 B—Tonsillar enlargement less marked than A, fewer inflamed follicles, and less adenitis.  
 C—Mild injection of the fauces and pharynx only, with tender tonsillar adenitis.

Grades of splenomegaly : 3—Palpable without inspiration.  
 2—Palpable on quiet respiration.  
 1—Palpable on maximal inspiration.

\*These cases had mild and transient enlargement of the posterior cervical glands.

of glandular fever, is really a reflection of the selected population served by this hospital. All the cases in this small series have been British, but since this paper was begun similar cases with normal hæmatology and serology have been seen in a 21-year-old Mauritian and in a Greek aged 18.

The splenomegaly might possibly be an unrelated coincident finding and many causes of splenic enlargement are known. The previous history of jaundice or malaria has been mentioned; septicæmic conditions can be virtually excluded by the negative blood cultures and by the rapid clinical recovery. Splenomegaly is a frequent finding in cases of "P.U.O.—Short



Term" seen in the Canal Zone, but, as mentioned earlier, the fact that the splenic enlargement and the tonsillitis progress and regress together indicates that they are in some way connected and are not unrelated findings.

The probable connection between the tonsillitis and the splenic enlargement is the removal or neutralization of absorbed streptococcal toxins by the spleen as the main organ in the reticulo-endothelial system. We think that this may occur more frequently than is realized in normal cases of tonsillitis, though a thorough search through the *Index Medicus* has failed to reveal any references to this combination of signs.

#### SUMMARY

A series of twenty cases of typical tonsillitis is presented, in which splenomegaly was a feature. Glandular fever can be discounted in all cases on cytological and serological evidence. The cause of the splenomegaly is suggested.

#### ACKNOWLEDGMENTS

We should like to thank Colonel J. A. G. Carmichael, Consulting Physician, M.E.L.F., who suggested this investigation; Lieut.-Colonel P. H. Shorthouse and his successor as O.C. Medical Division, Lieut.-Colonel R. G. Macfarlane, for their encouragement; Captain G. Eisinger, for the Paul-Bunnell tests; and other colleagues who have helped by examining or referring patients.

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# TRAUMATIC RUPTURE OF THE SPLEEN IN RUBELLA

BY

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and

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At the Cambridge Military Hospital in the past eighteen months there have been three cases of traumatic rupture of the spleen. Two cases were associated with severe trauma: (a) a close range blank cartridge wound splitting the splenic substance, and (b) a heavy blow with a milk bottle delivered by an irate wife—both causing severe bruising of the skin and muscles. The third case was due to a glancing blow, insufficient to bruise skin or muscles, by the tailboard of a lorry.

## CASE REPORT

Spr. C., aged 18 years, was admitted to C.M.H. at 5.30 p.m. on 13th February. He had been struck by the tailboard of a lorry on the left costal margin some one and a half hours previously. His unit was remote from the hospital and necessitated a twenty-mile drive. He had been given morphia gr.  $\frac{1}{4}$  by his unit M.O. to sedate him on the journey. On admission he was shocked, being pale and sweating, and complaining of generalized abdominal pain and over the lower left chest. He made no complaint of shoulder-tip pain.

On examination, his pulse rate was 95 per minute and blood pressure 70/40 mm. Hg. His abdomen was tense but no true rigidity was present. There was dullness on the left side of the abdomen, but no shifting dullness could be detected. His chest was free from abnormal signs. It was noted that there was no bruising or abrasion of the skin in the area of contact with the tailboard.

*Radiograph.*—No fractured ribs; no free gas in peritoneal cavity. A diagnosis of ruptured spleen was made, taking into account the effects of the morphia.

*Operation* (P. J. W.).—Left paramedian incision revealed free blood in peritoneal cavity. The spleen was ruptured in several pieces, having been torn completely from the splenic pedicle. At operation it was noted that the spleen was enlarged roughly three times that of the normal. He was transfused with two pints of blood during the operation. As a point of interest, it was noted that there was no muscle bruising at all. His post-operative course was uneventful apart from some degree of ileus of the gut, which was treated by gastric suction and intravenous fluids. On 19th February (sixth post-operative day) he complained of feeling unwell and his temperature was found to be 100.4° F. This was followed on the next day by the development of a fine maculo-papular rash all over his body. A diagnosis of rubella was made, and he was transferred

to the isolation ward. On 22nd February (ninth post-operative day) the wound was apparently healed and the sutures were removed. This was followed shortly after by bursting of the wound and prolapse of coils of small gut, omentum and colon. He was returned to the theatre where he was re-sutured. At operation it was observed that there had apparently been little or no evidence of healing of the wound. Post-operatively his condition never gave rise to a moment's anxiety and he was discharged on 14th March, with a firmly healed scar.

*Pathological Report.*—The spleen was slightly enlarged, with considerable lymphoid hyperplasia in non-traumatized tissue.

#### DISCUSSION

The points of interest in this case were :

- (a) The trivial nature of the trauma, associated with severe laceration of the spleen.
- (b) Development of rubella in the immediate post-operative period.
- (c) The failure of the wound to heal by first intention.

The literature dealing with traumatic rupture of the spleen was consulted and 146 references found. However, in all these, none referring to traumatic rupture of the spleen associated with rubella was found.

Rupture has been described in a series of conditions, kala-azar, malaria, infective mononucleosis and scarlet fever, all of which lead to alterations in the splenic substance. Similarly in rubella there is a generalized lymphadenopathy and an associated splenomegaly which may be sufficient to be palpable. In the American literature, reference to ruptured hyperplastic spleens is made (1)\* The microscopic picture was very much like that we have seen. In one case this was followed by the development of a fine maculo-papular rash which was diagnosed as sulphonamide sensitivity. The similarity in the cases described is further enhanced by the breakdown post-operatively of the wounds of two of the three cases described.

#### REFERENCE

- (1) LITTLEFIELD, *Surgery, Gynecology and Obstetrics*, February, 1946, p. 202.

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\* I made several attempts to contact the author of this particular article, as owing to the great similarity of certain features of the cases involved, I was particularly anxious to ascertain from him whether there was any possibility that in his cases the rashes described could in fact have been due to rubella. Unfortunately all attempts at contact failed, so in that respect no progress has been made.

# SOME MEDICAL MEMORIES OF TWO WORLD WARS

BY

**HUMPHREY HUMPHREYS\***

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MR. HASLAM, in whose memory this oration is given, was a man of most lovable character, one of those of whom it can truly be said that he had not an enemy in the world, and his familiar nickname of "Uncle" signifies the universal affection which he inspired. Trained at St. Thomas' Hospital in London, he was appointed Assistant Surgeon to the Birmingham General Hospital in 1882 and remained on the staff till the end of the First World War, when he retired; but not to a life of leisure, for he became Dean of the Medical Faculty and remained so for ten years. Your invitation to deliver this oration recalled old memories of his teaching, and I reflected that his career in some ways resembled my own for I, too, after practising for many years as a surgeon—of sorts—finished up as an administrator in this university. But we had another experience in common: we both served in the Royal Army Medical Corps of the Territorial Army throughout the First World War. In my own case I remained on the active list of that army till 1949 and I have, therefore, chosen as my theme a comparison of the British medical services in the two world wars in each of which I served for four years overseas.

It is commonly believed that the more lethal character of modern weapons has led to a great increase in the numbers killed in modern battles. But this belief is not borne out by the facts. Livy records that 50,000 Romans were killed at the battle of Cannæ (216 B.C.), all in hand-to-hand fighting in a single day. I had occasion not long ago to investigate the battle of Edgehill, the first of the Civil War, fought in Warwickshire on a Sunday afternoon late in October, 1643. The battle was not joined till three o'clock with a bare two hours of daylight left, the forces actually engaged probably numbered well under 20,000 men; no artillery was used, and all the fighting was at close quarters. Next day over 1,000 dead were buried on the battlefield, and there is no record of those who died as the result of the wounds they received. No battle in the last war records such a high percentage of killed in so short a time.

What has occurred since then is a great reduction in the numbers of deaths suffered by armies from sickness and this is directly due to advances in medical science. There are no reliable figures to illustrate this earlier than the Crimean War, in which the British losses from disease outnumbered those from enemy bullets by 10 to 1. The actual figures were 16,300 to 1,750, dysentery, typhus, typhoid and cholera being the chief killers. In the Sino-Japanese war of 1894,

\* Professor Humphreys will be better known to some of our readers as Colonel H. F. Humphreys, O.B.E., M.C., T.D., who had a distinguished career in the Territorial Army until his retirement in 1949. Colonel Humphreys was Honorary Physician to the King from 1934 to 1949. His article is reprinted from the *Queen's Medical Magazine* (Birmingham) by kind permission of the Editor.

the Japanese lost four men from disease to one from wounds ; in the South African War of 1899-1902 the corresponding British figure was 2 to 1 (14,000 to 8,000). But the recent lessons of those two wars were not lost on the Japanese and in their war with Russia in 1904-5 the figures were reversed ; the battle losses were four times as numerous as those from disease, the reduction in which was brought about mainly by sterilization of drinking water, proper disposal of refuse, and better rations.

By 1914 these lessons had been learnt by the British, and they were further aided by some new discoveries such as that of T.A.B. vaccine introduced by Almroth Wright in 1908. There is not, of course, time in a short lecture to give an accurate or detailed survey of the medical services in the two world wars, and it will be more interesting if I give, in general, round figures and use as illustrations my personal experiences. The size of the British Army in the last year of both wars—1918 and 1944—was much the same, about  $4\frac{1}{2}$  million men. The first war lasted for 51 months, the second 68, and it may seem surprising that the casualties of 1914-18 should have been far heavier than those for 1939-45. At the end of the one we mourned a million dead, almost exactly a million, of whom no less than a quarter (247,000) were numbered as missing as late as March, 1920, and can, therefore, be confidently counted amongst the killed. In 1946 this toll of the dead was just under a quarter of a million, to which we should add a high proportion of the 53,000 then missing. A tally of the wounded tells the same tale—2,100,000 in the first war, 277,000 in the second—roughly one-eighth of the former total in a war which lasted one-third as long again. This figure in itself shows that *the main cause of the contrast in mortality between the two wars lay in the different conditions of combat*, continuously at close quarters in the main theatre during World War I, intermittent and more mobile in World War II.

None the less, credit can be claimed by the medical services for part of the improvement. The years between the wars and the war years themselves had seen remarkable, indeed unprecedented, advances in medical science, some of which, such as the advent of the sulpha drugs, penicillin, D.D.T., and mepacrine—to name the most important—were directly applicable to Army problems. The complete medical history of the war has not yet been published, but it will be worth while to look at a few figures that are available and I shall consider chiefly the two theatres in which I myself served in one war or the other, the Middle East and South-East Asia.

*Typhoid Fever.*—The T.A.B. vaccine was introduced in 1908, but the British with their characteristic consideration for conscientious dissenters did not make it legally compulsory in the 1914-18 war. None the less, the vast majority of soldiers serving abroad in that war received it and typhoid, which in the Boer War had killed more men than enemy bullets, slew in 1914-18 only a little over 1,000 men, practically all unvaccinated. In 1939-45 the injection of T.A.B. vaccine was more strictly enforced, and this is shown by a comparison of the case incidence for typhoid in the Middle East : 3.07 per thousand in 1917, 0.74 per thousand in 1944.

*Dysentery* has always been a major scourge of armies. There is a graphic account by Joinville, one of St. Lewis' crusaders, of the destruction of his army by this disease, resulting in his capture by the Saracens. Attention to water supplies and improved camp sanitation did much to reduce it in both world wars by comparison with earlier campaigns. But a high proportion of the native population in the Middle East, India and South-East Asia are dysentery carriers, a substantial number of British troops who recover from dysentery become carriers for a time, and if either of these classes of personnel handle food supplies, food vessels or food implements, dysentery can be conveyed. Probably, indeed, this is today the main method of spread for the disease, whether amœbic or bacillary, and its incidence amongst troops in the Middle East was much the same in both wars. But improved methods of treatment, in particular the introduction of sulphaguanidine, greatly reduced the case mortality which, in 1917, was 3.2, in 1944 only 0.02 per cent. This factor of the carrier is perhaps today the most important and the most difficult of solution of the problems of epidemic disease. One striking example emerged in the Middle East where the incidence of jaundice following the treatment of syphilis by arsenical drugs became so high (43 per cent. of cases early in 1943) that it was thought to be an effect of the drug. The introduction of stricter methods for sterilizing and handling the syringes completely eliminated it. Infective hepatitis was the principal epidemic in that theatre.

*Malaria.*—In South-East Asia, where I served during 1944 and 1945, malaria was responsible for one-half of the total sickness rate and was, therefore, the most serious drain on the strength of both armies in that theatre—ourselves and the Japanese. But when the Fourteenth Army advanced into Burma towards the end of 1944 it had been convincingly demonstrated by Hamilton Fairley that a regular daily dose of mepacrine, though it did not, of course, prevent infection, would suppress symptoms and thus greatly reduce the casualties. Because it produced in most cases mild symptomless jaundice which was accompanied by slight loss of libido, the belief became current amongst troops that regular mepacrine impaired virility, and this led to widespread evasion of the daily dose. If placed on the tongue at a parade by an officer or orderly, it was slipped into the cheek instead of being swallowed, and spat out subsequently. Indian troops often saved the unswallowed tablets and later sold them to civilians for substantial sums. Finally, the responsibility was placed squarely on the shoulders of C.Os. of units, who were deprived of their command if their incidence of malaria rose above 5 per cent. After this, techniques were soon evolved which insured that the daily dose of mepacrine really was swallowed, and this was a most important factor in the reconquest of Burma by the Fourteenth Army in the winter and spring of 1944-5. The opposing armies were not greatly different in strength, the Japanese were masters of jungle warfare, but they were far more ravaged by sickness than ourselves. For they relied in the treatment and suppression of malaria on the relatively ineffective quinine of which they had a monopoly after their conquest of Java, where most of the world's supply was grown. More than 100,000 dead were

abandoned, unburied by the Japanese, in their six months' retreat—a high proportion of their total strength. The moral of this tale is the value of a satisfactory liaison between the medical and the fighting services of the Army, and the necessity for educating troops in the reasons for the rules of hygiene they are expected to observe. In that connection it is significant that in South-East Asia the evacuation rate for malaria was three and a half times as high for other ranks as it was for officers, since the rationale of regular mepacrine and anti-malarial measures was better appreciated by the latter.

It would be tedious to mention all the other scourges of war that have decimated armies in the past. Most of them—plague, cholera, diphtheria, yellow fever and typhus—had been mastered before 1914 so far as the British Army was concerned and were not important causes of casualties in either war. It is a significant contrast that in 1915 the Serbian Army, whose sanitary standards were much lower, lost one-quarter of its strength from typhus in six months. 1939-45 registered some advances. In both wars the first winter witnessed an extensive outbreak of cerebro-spinal meningitis, due to the overcrowding of newly recruited troops in billets and quarters, and many cases of pneumonia. In 1914-15 the death rate was high, in 1939-40 negligible owing to the use of sulpha drugs. Tetanus toxoid gave a satisfactory immunity and abolished the necessity for anti-tetanic serum after every wound, and this brings us to the question of surgery in the two wars where the contrasts are greater than in medicine.

#### SURGERY

The antibiotics, particularly the availability of penicillin in the latter part of the war when most of the heavy fighting took place, produced a dramatic change in the prospects of recovery from wounds. Equally important was the availability of blood banks and plasma in forward hospitals. Landsteiner had demonstrated the main blood groups before World War I and blood transfusions were employed in its hospitals, but on nothing like the extensive scale that was made possible in World War II. In 1914 there was little understanding of shock and it was all too often fatal. During 1939-45 the universal availability of whole blood and plasma transfusion deprived shock of its position as captain of the kings of death in the surgical wards. *With the antibiotics and blood transfusion went improvements in surgical technique.* The most dramatic of these was that of complete immobilization of compound fractures by plaster of Paris, the excision of damaged and infected tissue, and then a rest for the wound instead of the frequent irrigations by Carrel Dakin solution which had been the fashion in 1916-18, or the antiseptic applications which were common in the early part of that war. This new technique had been first demonstrated on a large scale by Trueta in Barcelona during the Spanish civil war. He claimed to have treated 20,000 compound fractures with only 91 bad results and only four amputations. The essence of it was the provision of rest for the damaged tissues, and this ideal was made more easy of attainment by *an enormous improvement in the methods of collecting and evacuating wounded* which the second war

shows, when compared with the first. I believe that this factor has been insufficiently appreciated in discussions of the medical services. It was, of course, due to the greatly improved methods of transport that had become available, and I can best illustrate it by an account of my personal experiences.

In both wars I served with armies operating in areas not well suited for transport, Sinai, Palestine and Syria in the first war, South-East Asia in the second. In the battles late in 1917 which resulted in the capture of Jerusalem I was D.A.D.M.S. of the Yeomanry Mounted Division. In that campaign, and still more in the advance on Damascus the following year, cavalry played an important, indeed a decisive, part—the last war in which it is ever likely to do so. After the Turkish line between Gaza and Beersheba was turned in October, 1917, the cavalry rode ahead and my division advanced up the valley of Ajalon—where, you may remember, the sun stood still for Joshua in a battle over 3,000 years earlier, where David pursued the Philistines from Gideon even unto Gezer, where Judas Maccabæus, the Romans, and the Crusaders had all in turn advanced on Jerusalem. Our object was to cut the road which ran along the crest of the Judæan highland and supplied Jerusalem from the north. As soon as we left the plains at Ramleh and began to climb, the going got steadily worse, and by the second day wheeled transport became impossible: guns and ambulances had to be left behind and all we had for the transport of wounded were camels carrying cacolets—a form of double litter, one on each side of the hump. Very soon the track became so choked with boulders that we all dismounted and led our horses. Opposition began to stiffen, we were over 2,000 feet up and very cold, being clad in light khaki drill, while most of the men had had nothing to eat all day. The next day we advanced again, but in the afternoon, when four miles from our objective, we were heavily attacked by a Turkish infantry division supported by artillery, and had to retire a few miles. Luckily it was getting dusk and the Turks did not follow us up, which enabled myself and two field ambulance officers with their bearer sections to collect the wounded, while a thin rear-guard held off the enemy patrols. We had about thirty camels which took the worst casualties and the others, about a hundred, had to ride on horses, even some with broken legs. That is, they rode in the dark along a rough track which sound men in daylight had negotiated dismounted. We made off at 7.30 and it was after midnight before we had got back behind the line it had been decided to hold and could get the wounded men off-loaded. Next morning they started off again and after travelling all day reached a field ambulance dressing station where they could be dressed and fed. Here forty more camels with cacolets were available, and the day following (their third successive day of travel) the wounded were transported by these to a receiving station at Ramleh in the plains—a sort of advanced casualty clearing station where some sort of emergency surgical treatment was possible. A number had died on this long journey. The main C.C.S. was fifty miles away over rough unmetalled road and the nearest properly equipped hospital was 130 miles farther on the Suez Canal. Few, if any, casualties reached that within a week of being wounded.



Contrast this with the conditions of the Burma campaign in the winter and spring of 1944-5. I was then commanding a British Field Hospital, which after being overrun by the Japanese near Imphal in April, 1944, had been flown back to Assam. By the time the Fourteenth Army advanced again in the autumn of that year and captured Mandalay it was hundreds of miles from its railhead, connected therewith only by a jungle road, so that its ammunition, supplies and reinforcements had to be conveyed entirely by air. That made the convoy of all casualties by air not only possible but necessary and their evacuation was on these lines. Bulldozers operated at brigade level, and while a battle was in progress they knocked down the little dykes separating the level ricefields and prepared in an hour or two a landing ground a few hundred yards long, enough for light L.5 aeroplanes to land. Casualties on stretchers were loaded on to jeeps which then ran down to the new airstrip and transferred them to the L.5s. These would then take off with one case each and land at a larger airfield (constructed previously by the Japs) where a C.C.S. and forward surgical unit would be stationed. This journey might take one-quarter of an hour or more. Some cases needing immediate operation, such as abdominal wounds, were detained at the C.C.S., so were very light wounds and cases of sickness likely to be fit for duty within a week. But the rest were loaded forthwith into Dakotas, which took about forty casualties each, and flown straight back, "over the hump" as we called the high ranges bordering Burma, to my hospital in Assam. So that a man shot through the head in a dawn attack was on our operating table at six o'clock the same evening, having travelled 500 miles or more.

The effect of this rapid evacuation on the healing of wounds was dramatic. Every wounded man received three-hourly injections of penicillin, so that no wounds became septic; blood or plasma transfusions were available for all requiring them so that the effects of shock were largely eliminated; fractures were immobilized on the day they occurred and remained so till union had taken place. Most striking of all were the results on the morale of the men and their confidence of recovery. Men when first wounded often seem surprisingly little affected: they may march a mile or more on a leg that is subsequently amputated. It is half a day later that the reaction and shock are made manifest. In Burma the men by that time were on a hospital bed, after a few hours' rest in the plane, with an English nurse taking their pulse and the patients in neighbouring beds assuring them, "Cheer up, chum; no one ever dies in this 'ere 'orspital!" I often heard that remark when I was watching the admission of convoys, and it was not far from the truth, for death was a rare occurrence. We were the most forward of the British Field Hospitals and received nearly all the British casualties evacuated from Burma during the period of heavy fighting; in the final phase of the advance on Rangoon many were evacuated by sea. We detained all dangerously wounded cases and passed on most of the others to hospitals in our rear so as to have beds available for the daily convoys. In the first war, hospitals filling such a role and dealing with wounded evacuated under the conditions I have described in Palestine expected a death-rate of

5 to 10 per cent. In the Burma campaign we admitted over 11,000 casualties in five months, and might have expected—in the conditions of 1914-18—perhaps a thousand deaths. Our actual deaths in that period numbered 23. That figure illustrates more eloquently than any words the difference in the medical services of the two wars. It is the more surprising since we were working in a very trying climate in a temperature that seldom fell below 90° F. with a 90 per cent. humidity. Our wards were overcrowded canvas marquees, our amenities non-existent. But we had erected an adequate operating theatre, built of mud bricks in a month and air-conditioned by a plant requisitioned in Calcutta, and that made all the difference to the surgeons and to the wounded.

## TYPHUS IN OXFORDSHIRE BILLETS, 1643-4

BY

Dr. W. O. HASSALL

*The Bodleian Library, Oxford*

It has long been known that the establishment of Royalist headquarters at Oxford and the consequent overcrowded conditions led to an outbreak of typhus in 1643 in villages situated within some six miles of the city. This unpleasant consequence of billeting was deplored at the time, but an assessment of the mortality from the numbers of burials in the parish registers is vitiated by our ignorance of village population figures.

The village of Wheatley was of considerable strategic importance as it was a "town" only six miles from Oxford, on the eastern approaches, which, as facing the Parliamentary headquarters at London, was the most threatened side. Furthermore, it lies at the point where what was once one of the five chief roads of England crosses the Thames and makes towards Chipping Norton and Worcester. Wheatley was accordingly designated as a frontier place in the Treaty of Uxbridge. It so happens that a number of chance survivals of documents make a calculation of the population of Wheatley in the two centuries before the first census returns in 1801 rather more practicable than it is elsewhere.

Use of parish register evidence is somewhat harder in the case of Wheatley, at first glance, than it is in other villages; for Wheatley was a hamlet in the parish of Cuddesdon and it is not therefore possible to be always certain whether a particular entry relates to the present village of Wheatley or to Cuddesdon. The relatively high proportion of the parishioners living in Wheatley is indicated by the Hearth Tax Returns of 1665, which list 11 householders in Cuddesdon, 1 and 4 in its little hamlets of Chippinghurst and Denton, and 35 in Wheatley.

The houses assessed for hearth-tax did not include anything like all the houses in a village, as an estate map which shows drawings of the houses at Emmington and a deed which lists the cottagers of Aston Rowant indicate. In Wheatley there happens to survive a list of communicants for 1612-3 and this shows that there were 32 dwellings on the south side of the High Street and 45 on the north. In 1581 cottages at Wheatley had been described as modern, but the evidence of a convenient lawsuit of 1687 shows there were then 92 cottages and that apparently no new ones had been built since 1631, though it is known that first 5 and then 9 new cottages had been built shortly before then. By 1759 there were 140 dwellings, housing 800 families, poor families having many children, according to a report to the bishop.

Against this background the figures for burials in the Cuddesdon parish register acquire rather more meaning than those for other villages of which the population can only be a matter of surmise. For the decade 1632-1642 there were on an average 21 annual deaths. In 1643-4 there were three times as many burials, 52 in 1643 and 73 in 1644. Despite great poverty in the nineteenth

John Brooke and Grace Styles were married February 16.

## Burialls Cuddesdon. 1644.

John the husband of Alice Robinson was buried March	25
Isabell the wife of John Cox was buried March	29
Henry the son of Henry Laurence was buried April	9
A souldier was buried at Whately April	15
William the husband of Amy Bandy buried June	3
Christopher the husband of Alice Tenny buried June	3
Estlinor the wife of Ralph George was buried July	4
John the son of Richard Simms was buried July	16
Jane the daughter of James Heath was buried July	16
Elisabeth the wife of Richard Simms was buried July	18
James the son of James Heath was buried July	18
Ralph George was buried July	20
Vincent Audley the husband of Alice was buried July	21
Elisabeth the daughter of John Traugh was buried July	28
Margaret & 3 other children of James Heath were buried July	30
Frances	
James Heath the husband of Martha was buried August	11
Jane Mepinger widow was buried August	20
Elisabeth Laurence widow was buried August	20
Alice the wife of Matthew Langstone was buried August	23
Cecily the wife of John Laurence was buried August	23
Elizabeth the daughter of Thomas Allen was buried August	28
Mary Price widow was buried August	29
John the son of Richard Buckley was buried August	30
Ann the daughter of William Platt was buried August	30
Robertine the son of James Mepinger was buried August	30
Jane the daughter of George Cross was buried August	31
John the son of John Laurence was buried Sept	3
William the husband of Elisabeth Frankling was buried Sept	3
Mary the daughter of John Traugh was buried Sept	5
Martha the daughter of Matthew Langstone was buried Sept	6
Thomas the son of Thomas Page was buried Sept	6
Elisabeth Laurence widow was buried Sept	8
Mary the daughter of Thomas Allen was buried Sept	8

This day came newes that *Bulmore* one of the *Scoutsmasters* of the *Rebels* Army, (a fellow that had robbed more passengers, rifled more Carriers, and intercepted more letters, then all the villaines in the pack) was killed at *Whateley* by a Gentleman in His Majesties service: who faining himself (being asked the question) to be for the *King and Parliament*, rid quietly with him and his Associates being 16 in number, untill they came to *Whateley* Bridge. *Bulmore* and his companions having a designe to give an alarme to His Majesties quarters. But the Gentleman spying an handsome opportunity, shot him in the head, and strooke him stone dead (as they say) with a pocket-pistol, and making speed into the Towne raised up His Majesties Horse which were quartered there, and pursued the *Rebels*, who made such halt to save themselves, that they cast downe the senselesse Carcasse of their Leader, which by His Majesties souldiers was conveyed to *Whateley*, where it lay open for a time a spectacle of contempt and scorn to the eyes of all men.

THURSDAY. May 4. [1647]

EXTRACT FROM ROYALIST NEWSPAPER, "MERCURIUS AULICUS"

century, Wheatley attracted immigrants because of its reputation for health, and there were only 15, 14 and 16 deaths in 1887-8, 1889-91 and 1894-5—i.e., 17.3 per 1,000—despite cases of typhoid due to ill-feeding.

It may be remarked that the unnamed soldier in the part of the parish register reproduced was probably not a Royalist soldier who had succumbed to typhus. Five days before, the Royalists had killed, near Wheatley Bridge, Balmore, "one of the Scout-masters of the Rebels Army (a fellow that had robbed more passengers, rifled more carriers, and intercepted more letters than all the villaines in the pack)." According to the Royalist paper *Mercurius Aulicus*, his "senselesse carkesse . . . was conveyed to Whateley, where it lay open for a time a spectacle of contempt and scorne to the eies of all men."

(See: Nias, J. B., "Typhoid Fever in the Civil War," Seventeenth Internat. Cong. Med. (London, 1918), sect. xxiii, pp. 340-341.)

## INCIDENCE OF PULMONARY TUBERCULOSIS AMONGST NATIONAL SERVICE MEN

BY

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DURING the years 1950 and 1951, while I was acting as medical officer to Manchester Garrison, sporadic cases of pulmonary tuberculosis came to light amongst young National Service men who were undergoing their full-time service. While the incidence did not cause alarm, it was considered sufficiently important to justify a visit from an Army M.M.R. team. The Manchester Garrison Medical Centre is located in the Army Pay Office (Officers' Accounts), Stockport Road, Manchester, in which building the bulk of National Service men in Manchester area are employed.

The centre had its first visit from No. 7 M.M.R. Team, Western Command, in March, 1952. The visit was repeated in February, 1953, in June, 1953, in September, 1953, and again in March, 1954. The reason for the repeated investigations in 1953 was that in each instance a case of pulmonary tuberculosis was discovered and confirmed by further investigation. This was considered of sufficient significance to justify repeat investigation by M.M.R. as every case was that of a young man or woman in the late 'teens. A feature of note was that in each case previous radiological examination of the chest had been carried out within a relatively short period with no abnormality seen.

Approximately 450 personnel were examined on each of the five visits of the M.M.R. team, of whom 90 per cent. were National Service employed at the Army Pay Office. Troops at this office live in private billets in the neighbourhood and supervision of their leisure hours in the evenings and week-ends is more than difficult. In many cases the lure of the dance hall or picture house is more attractive than an outdoor game or sport.

Analysis of M.M.R. examination shows interesting results, as a result of which more rigorous chest supervision is now enforced in this area. In all the cases examined, a routine chest radiograph had been carried out prior to enlistment at the behest of the Ministry of Labour and National Service.

### VISITS BY NO. 7 M.M.R. TEAM, WESTERN COMMAND

#### 1. MARCH, 1952 : Total radiographed—414.

*Result.*—One case of pulmonary tuberculosis diagnosed and confirmed. National Service man, aged 19. This soldier was radiographed in July, 1951, prior to enlistment. He had completed seven months' service. Category FE. No previous history of illness.

## 2. FEBRUARY, 1953 : Total radiographed—445.

*Result.*—One case of pulmonary tuberculosis diagnosed and confirmed. National Service man, aged 19. Eleven months' service. This soldier was radiographed in January, 1952, prior to enlistment. Category FE. No previous history of illness.

## 3. JUNE, 1953 : Total radiographed—347.

*Result.*—One case of pulmonary tuberculosis diagnosed and confirmed. National Service man, aged 19. Eleven months' service. This soldier was radiographed in May, 1952, prior to enlistment. Further radiograph by M.M.R., February, 1953. No abnormality discovered on either occasion. No history of illness between February and June, 1953. Never reported sick during that period. Category FE.

## 4. SEPTEMBER, 1953 : Total radiographed—486.

*Result.*—One case of pulmonary tuberculosis diagnosed and confirmed. W.R.A.C., aged 20. Five months' service only. Radiographed prior to enlistment. Category FE. No history of illness during period of service.

## 5. MARCH, 1954 : Total radiographed—528.

*Result.*—One case of pulmonary tuberculosis diagnosed and confirmed. National Service man, aged 20. Twenty-one months' service. Previous chest investigations :

May, 1952. Radiograph prior to enlistment.

February, 1953	} M.M.R. Manchester. None showed any chest abnormality.
June, 1953	
September, 1953	

No history of illness during military service. Category FE throughout.

Date of M.M.R.	Total radiographed	Confirmed pulmonary tuberculosis	Previous illness during service	Medical Cat.	Last radiograph of chest
March, 1952 ...	414	One	Nil	FE	8 months previously
February, 1953	445	One	Nil	FE	13 months previously
June, 1953 ...	347	One	Nil	FE	4 months previously
September, 1953	486	One	Nil	FE	6 months previously
March, 1954 ...	528	One	Nil	FE	6 months previously

As the total intake of National Service personnel during the period March, 1952, to March, 1954, in this area was between 500 and 600, it will be seen that the total number investigated was about one thousand, intakes having balanced releases. This gives an approximate total morbidity of five cases per thousand,



although each separate visit of M.M.R. team gives a morbidity of approximately two per thousand per visit, which is statistically more correct.

Over the Manchester area, in an industrial belt covering a population of over two million, the incidence of pulmonary tuberculosis diagnosed on M.M.R. is approximately two per thousand. This covers all age groups except children. It is impossible to compare the two sets of findings with statistical accuracy, since all troops were investigated at the Medical Centre, whereas large numbers of civilians refuse to be investigated by M.M.R. ; nevertheless, the results must be viewed with some apprehension.

Neither service nor civil statistical returns take into account cases of pulmonary tuberculosis diagnosed on examination or after history of hæmoptysis, loss of weight, etc. It is worthy of note that all National Service men had already had chest radiographs before enlistment and therefore they presumably represent a healthy cross-section of the population from whom a lower incidence of pulmonary tuberculosis would normally be anticipated.

In the year 1951, the Senior Administrative Medical Officer, Manchester Regional Hospital Board, reports that 10,225 National Service recruits were examined by M.M.R. in the Manchester area. Nineteen cases of pulmonary tuberculosis were discovered, giving a morbidity of just under two per thousand.

#### DISCUSSION AND CONCLUSION

It is accepted amongst chest physicians that the susceptibility to pulmonary tuberculosis is higher than average in the late 'teens. This is borne out in repeated annual reports of the M.M.R. service of the Manchester Regional Hospital Board, and is apparently confirmed to a marked degree over the period during which routine M.M.R. examinations were made on National Service men in Manchester in 1952-1954.

As a result, the policy now adopted in the Garrison Medical Centre, Manchester, is as follows :

- (1) All National Service personnel are radiographed *at least* once per year.
- (2) All service personnel are radiographed before service overseas. This fact is recorded on the certificate of fitness to serve overseas.
- (3) All service personnel have radiological examination of chest on return from overseas.
- (4) All service personnel are radiographed prior to completion of Form MED 28 for release.

The last three examinations are conditional on no radiological examination of the chest having been carried out within the preceding three months.

Chest radiological examinations are carried out at short notice by appointment at Manchester Chest Clinic or at the Department of Radiology, Stockport Infirmary.

If the results obtained from investigations in Manchester represent a true cross-section of conditions existing generally amongst service personnel, it would imply that the ideal method of chest supervision amongst *National Service* personnel is as follows :

- (a) Radiological examination of chest on medical examination prior to enlistment (already carried out, with very few escaping the net).
- (b) Second examination at end of one year's service.
- (c) Third examination prior to medical examination on release—*i.e.*, after twenty-three months' service.
- (d) Additional chest radiological examination prior to service overseas and on return from such service. To those of us who have served overseas it appears obvious that this could save considerable manpower and unnecessary public expense, and furthermore would increase the confidence of the public in the medical services of the armed forces.

Such radiological examinations could be carried out by Army M.M.R. teams where available and where numbers justify such a visit, and otherwise by local hospitals and chest clinics with the co-operation of Regional Hospital Boards. In my experience civil health authorities are very willing to co-operate in any matter which will assist in maintaining the health of service personnel.

In this connection I should like to express my gratitude to Dr. M. J. Greenberg, Consultant Chest Physician, Manchester, and to Major D. M. Coates, R.A.M.C. (T.A.), Consultant Radiologist, Stockport Infirmary, for the efficiency and courtesy with which they have been ready at all times to carry out chest examinations.

*Note.*—War Office states that after the initial examination on joining, M.M.R. is repeated as frequently as resources allow. A three-yearly period is considered the maximum and, where facilities are easily available, annual review is undertaken. Pre-release examination is carried out whenever possible. Assistance from civil sources is not always easily available, particularly to units in the less populous areas. To avoid the uneconomical use of resources, larger units are now often examined as a whole regardless of when individual soldiers were previously examined.)

# REMINISCENCE OF ARMY MALARIA CONTROL

BY

**Captain KARL HECTER SCHULZ\***

*South African Medical Corps*

*Brigade Hygiene Officer, 6th S.A. Armoured Division, A.C.F., U.D.F.*

IN the Union Defence Force in World War II malaria control was carried out by men in the Hygiene Section of the S.A.M.C., who had training in civilian life to deal with such a problem under African conditions. Responsibility for enforcing all sanitary requirements, including anti-malarial precautions, rested with unit commanders, who were advised by the medical officers attached to formations. Practical demonstration and supervision of actual measures put into operation were carried out by officers and non-commissioned officers of the Hygiene Section of the S.A.M.C. which was on detached duty to individual formations. The training and experience of these men could deal with any situation arising out of the known conditions, but when it became evident that the newly formed South African Armoured Division was to operate under totally different conditions to those which the Union Defence Force had hitherto experienced, a special unit was formed whose duties would be solely that of malaria control.

This unit was known as "A.M.C.U." (anti-malarial control unit) and it was to be highly mobile. The personnel were drawn from the Hygiene Section attached to the 6th South African Armoured Division, preference being given to men who had training or experience of this work in the past. There was Jimmy, John, Lappies, Buck, Joe, Frikkie, Coatsie, and myself; the unit functioned under Peter, who was Divisional Hygiene Officer. Up to now we had been dealing with malaria vectors common to the Ethiopian region and those of the South Mediterranean littoral, so the first thing to be done was to give the personnel of the new unit instruction and experience in the control of the vectors and conditions which might be encountered in the new operational theatre. Instruction was given at Maadi in Egypt by a special British Army group, many of whom were world authorities on malaria. The training was thorough and revolutionary, and in fact laid a foundation on which future studies could be based. For experience the A.M.C.U. was sent to Syria where the personnel were attached to various British Army Malaria Control Units and worked under conditions which were afterwards found to approximate to those in the Balkan States and Southern Italy.

After its return the unit was dispersed and only brought on to a war establish-

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\* Now on the staff of the Plague Research Laboratory, Union Health Department, P.O. Box 1038 Johannesburg. This paper is published by permission of the Secretary for Health and A.G., Union Defence Force.

ment footing on the eve of the departure of the 6th S.A. Armoured Division, "destination unknown." In the meantime the Division had received its first instruction in the new malaria drill, and all personnel were equipped with individual mosquito nets and a small container filled with insect repellent liquid at one end and mepacrine tablets at the other. The A.M.C.U. had three three-ton trucks, one jeep and six motor-cycles allotted to it; war stores consisted of a wonderful array of tools for drainage work, and pumps and rotary dusters for the application of insecticides. Anti-malarial policy had been decided on and was to be as follows:

- (1) Front-line precautions. Troops in battle areas were to rely on protective clothing, the application of insect repellents, and on chemoprophylaxis. Under all conditions, when circumstances allowed, troops were to sleep under nets.
- (2) Battle echelon areas. Precautions here to be the same as above with the additional use of insecticides.
- (3) Lines of communications and base camps. Protective clothes to be worn, nets to be used, and permanent anti-malarial works to be carried out, in conjunction with the use of insecticides and larvicides.

After embarkation it was certain that the destination of the convoy was Italy, and although our troops operated in areas where the civilian malaria rates had risen to alarming proportions because of the breakdown in health services and lack of insecticides and anti-malarials, our infection rates were amongst the lowest in the Allied armies exposed to malaria infection.

On landing in Italy mosquito control at first was an easy matter, with the Division static in its concentration area in Puglie, routine anti-malarial measures plus mosquito surveys being carried out. But when the tide turned at Cassino and the German wall of resistance collapsed the front moved so fast and halts *en route* were of such short duration that the organization and equipment of the A.M.C.U. could not deal with the situation. It was realized that reorganization on real mobile principles, and relying on the one thing that a "mosquito flying squad" could effectively carry out—*i.e.*, anti-adult spraying of mosquito resting places—was required. A few members of the A.M.C.U. had already been drafted back to hygiene and ambulance duties, and north of Rome the remainder of the unit was disbanded, only myself remaining with divisional headquarters. A mobile spraying unit, consisting of a small Austin truck on which was mounted a compressor unit, was attached to our Division from Army Command. This was manned by a driver and spray operator, with myself forming a third member of the crew. We were really mobile, and for a single spraying unit did remarkably well, the only fault in the new set-up being that one spraying unit could not deal effectively with all the work required of it.

The spraying unit worked on the divisional axis; it was always attached to the leading Field Ambulance, doing duty to the brigade in action at the time, leap-frogging to the new Field Ambulance as that advanced forward of the position taken up by the former ambulance so that the spray unit was always

in a leading position, spraying out all houses, stables and piggeries taken by the infantry, and working backwards on the man axis till a new area was liberated. All premises which could be entered or occupied by our troops were sprayed out with Army "Flit," as were all the houses bordering the roads in the divisional area.

Theoretically, there was to have been a spraying team attached to Army and working on the divisional axis to connect up with the areas treated by us. But due to the large area covered on the divisional front we were never able to work backwards far enough to meet the Army spraying team, following up. The job was too big for the personnel and equipment allocated to do it.

In July, 1944, we were visited by an officer from the 10th British Mobile Malaria Laboratory, who brought with him some of the new wonder insecticide which we had heard about, but had not seen up to now. We were instructed in the use of this new insecticide called D.D.T., and from that time onwards it replaced Flit for the control of adult mosquitoes. The publicity which D.D.T. received at that time was perhaps unfortunate, because the uninitiated criticized its apparent lack of power without knowing about its residual lethal effects over long periods. People expected to see insects shocked into instant death on coming in contact with a treated surface, or thought that it had repellent properties, and condemned it on the evidence of large numbers of flies crawling about on treated surfaces, not realizing that this was due to the rate of influx from outside breeding places. It was found that the delivery nozzle of the spray gun had to be changed to deliver droplets instead of a mist as required when spraying Flit, and of course the internal surfaces of all walls and ceilings of houses were coated with D.D.T., instead of producing a fine concentration as had been done in the past with Flit. All premises treated were marked in a conspicuous place D.D.T., and the date of treatment appeared under these letters. The painting of this sign reminded me of the gigantic wayside signs we had passed on some roads erected by Army, such as "*Eighth Army can Beat Malaria.*" showing pictures of a soldier wearing slacks and sleeves rolled down, getting ready to take his mepacrine.

The malaria transmission season drew to an end, the Division began to operate in areas where malaria had not been known to exist before, so the spray team was withdrawn towards the beginning of October. Reliance was now placed entirely on personal prophylactic measures, and only mosquito field survey work was continued. Late in October the Division began to climb the pass north of Florence and preparations for the bloody battles of Monte Stanco and Monte Sole were commenced. We were out of the malarious areas now, facing the enemy dug into his winter line. Only on approaching the River Po would the danger of transmission recur.

In the meanwhile I was privileged to spend considerable time in a British Army Malaria Laboratory in Rome learning the biology of the vectors of this region, and became attached to U.D.F. Administration Headquarters where I set up a small entomological laboratory. My duties now were to do mosquito surveys under the direction of the Senior Officer Hygiene in areas occupied by

non-divisional units and to advise on measures to be adopted for the control of mosquito breeding round these camp sites.

The type of malaria control practised in the U.D.F. was similar to measures advised to be carried out for all Allied armies operating in Italy. The standard of efficiency of the personnel who enforced these measures, plus the whole-hearted response on the part of the soldiers, resulted in a very high standard of anti-malarial discipline which ensured a low rate of malaria infection in our troops. The new insecticide D.D.T., although used only for the protection of Army formations, did in fact keep down the rate of infection in isolated groups of the civilian population inhabiting troop areas, large areas round camps being treated on the principle of preventing anopheline mosquitoes from moving into camp after becoming infected through feeding on these civilians. Thus, while the rates of infection amongst the total civilian population were rising steadily there were islands in the rising tide where the rates of new infection remained static for the period during which the Army sprayed D.D.T. So although the Italian health authorities were in the dark as to the use and properties of D.D.T., part of the peasant population had already experienced its benefits. Italian malariologists who had hitherto relied on Paris Green for their mosquito measures were quick to realize the immense potential of D.D.T. for malaria control in rural and semi-rural areas.

# A NOTE ON 100 CASES OF HELMINTHIASIS WITH SPECIAL REFERENCE TO EOSINOPHILIA

BY

Captain P. G. CRONK, M.B.(Cantab.)

*Royal Army Medical Corps**British Military Hospital, Fayid.*

PARASITIC infestations are extremely common in Mauritian and East African troops and, as is well known, are responsible for a good deal of chronic malaise and debility. To the medical officer newly arrived in the Middle East, the therapeutic effect of anthelmintics on cases that would have been diagnosed in U.K. (and often were at their units) as hysteria, functional dyspepsia, dysentery, or neurosis was most rewarding.

Most of the patients were Mauritians, but about 15 per cent. were East Africans. Early in the series, all cases of parasitic diseases were included, but the last forty were selected because *Ankylostomes* were present. The cases were seen over a period of four months.

## 1. Analysis of Types of Infestation

<i>Ankylostoma duodenale</i> only	...	...	...	...	...	60
<i>A. duodenale</i> and <i>Ascaris lumbricoides</i>	...	...	...	...	...	15
<i>A. duodenale</i> and <i>Tænia</i>	...	...	...	...	...	1
<i>A. duodenale</i> and <i>S. hæmatobium</i>	...	...	...	...	...	1
<i>Asc. lumbricoides</i> only	...	...	...	...	...	15
<i>Schistosoma hæmatobium</i>	...	...	...	...	...	5
<i>Strongyloides stercoralis</i>	...	...	...	...	...	1
<i>Tænia</i> only	...	...	...	...	...	2
						100

(*Trichuris trichiura*—the whip worm—was frequently present, but was regarded as non-pathogenic.)

## 2. Presenting symptoms. These fell into seven main groups :

(i) Pain referable to the upper alimentary tract, "functional" abdominal pain, "duodenal ulcer," vomiting, etc.	...	...	...	22
(ii) Lower alimentary symptoms: Diarrhœa with blood or mucus with vague generalized abdominal ache	...	...	...	24
(iii) Neurosis: Hysteria, fits, "blackouts," muscular aches	...	...	...	16
(iv) Frank anæmia, <i>i.e.</i> , hæmoglobin of less than 70 per cent.	...	...	...	5
(v) Hæmaturia + dysuria (schistosomiasis)	...	...	...	3
(vi) Meningism	...	...	...	2
(vii) No special symptoms—parasites found in the course of lobar pneumonia, tonsillitis, headache, etc.	...	...	...	28
				100

Only in one patient was a duodenal ulcer demonstrated by barium meal, after the administration of anthelminthics.

In two cases a fairly confident diagnosis of meningitis was made, but lumbar puncture revealed completely normal C.S.F. ; the meningeal signs subsided within 36-48 hours after anthelminthics had been given.

### 3. *Anæmia*

Thirty-one cases of hookworm infestation had hæmoglobin estimations done, but in only seven cases was anæmia present (*i.e.*, hæmoglobin under 70 per cent.) ; usually the anæmia was gross, of the order of 20-30 per cent. hæmoglobin, with hypochromic red cells.

### 4. *Eosinophil Counts*

These were done on all cases, and the results (in absolute values) are as under :

Eosinophils per cu. mm.	0	1-400	401- 1,000	1,001- 3,000	More than 3,000
Parasites :					
<i>A. duodenale</i> alone ...	2	15	26	14	3
<i>A. duodenale</i> and <i>Ascaris</i> ...	1	2	7	2	3
<i>Ascaris</i> alone ...	4	2	8	1	
Ankylostomiasis + schistomiasis ...	1				
<i>Tænia</i> + ankylostomiasis ...		1			
<i>Tænia</i> alone ...		1		1	
<i>Strongyloides stercoralis</i> ...				1	
Schistomiasis ...			4	1	
	8	20	4	20	6

In addition, four patients showed considerable eosinophilia (1,760, 1,540, 1,360 and 885 per cu.mm.), but examination of 5 or 6 stools was negative. Schistosomiasis was excluded.

Taking the upper limit of normal as 400 per cu.mm., eosinophilia in all types of helminthiasis was mild in 46 per cent., marked in 20 per cent. and gross in 6 per cent. of cases.

The maximum count was 5,000 eosinophils in a case of ankylostomiasis (total count, 17,700 cu.mm.). This patient was not anæmic or asthmatic.

Fifty-four of 77 cases of hookworm infestation showed significant eosinophilia.

### 5. *Treatment*

Standard anthelmintic treatment for ankylostomiasis was 4 c.c. tetrachlorethylene, 1 c.c. oil of chenopodium and 240 gr. of magnesium sulphate dissolved in 2 oz. of water, administered on an empty stomach and preceded



and followed by more magnesium sulphate. Surprisingly, such massive purgation usually produced only mild diarrhœa.

This treatment was effective in relieving symptoms in most cases, but in about 20 per cent. a second dose was necessary. Only in one case was treatment a failure, *A. duodenale* being found in the stools with monotonous regularity six days after each of six courses of standard "deworming" and after two doses of carbon tetrachloride; his dyspepsia and epigastric tenderness were still present after this régime.

Hexyl resorcinol gr. 15 was effective in ascariasis and filix mas 60 min. or mepacrine was used in tæniasis. Stibophen (a course of ten injections, 5 c.c. of 7 per cent solution) seemed effective in schistosomiasis. Gentian violet (both orally and by duodenal tube) was used in treating strongyloidiasis without success.

#### SUMMARY

The presenting symptoms of 100 cases of various types of helminthiasis are listed, and treatment in use at this hospital mentioned.

Some three-quarters of the cases showed a significant eosinophilia; only seven cases were markedly anæmic.

## A CASE OF ABDOMINAL PREGNANCY

BY

Captain N. E. QUIN  
*Royal Army Medical Corps*  
*Junior Specialist in Surgery*

THE following case may be of interest owing to its rare occurrence :

### CASE REPORT

An African woman, aged 24, was admitted to the British Station Hospital, Nanyuki, on 9th July, 1954.

She gave a history of being four months pregnant. During the first three months she had been symptom-free, but during the last month had suffered from recurring attacks of colic in the lower and right side of the abdomen.

One week previous to admission there had been a vaginal hæmorrhage, lasting three to four days. She had also been complaining of nausea and occasional vomiting after meals for about three weeks. The bowels were constipated, the last motion being six days before admission.

Previously she had been healthy, and the menses regular. She had one child four years old, and pregnancy and labour were normal.

On examination there was a smooth swelling in the lower abdomen, rising out of the pelvis to a height of 3 inches (7.5 cm.) above the pubis in the midline. The lower abdomen was very tender and guarding was present.

On vaginal examination a firm, tender mass was felt in the pouch of Douglas, filling the pelvis. The cervix was closed and could be moved independently of the mass. There was a little old blood on the examining finger.

Operation was decided upon and the abdomen opened by a lower midline incision under general anæsthesia.

There was no free fluid in the peritoneal cavity, but the uterus was seen to be enlarged to about 4 inches (10 cm.) in length. It was pushed forwards and upwards by the pelvic mass. The bowel and omentum were attached by adhesions to the top of the uterus, the adhesions extending on each side to the walls of the pelvis. The general appearance was like endometriosis with a few "chocolate cysts" in the omentum.

During the freeing of the adhesions a profuse hæmorrhage started, and a large cavity was felt behind the uterus. The patient's condition deteriorated rapidly and intravenous infusion of "Dextran" was commenced and followed by transfusion of blood. At this stage the uterus could not be pulled forward and it was decided to remove it in order to control the serious hæmorrhage.

A subtotal hysterectomy was carried out as quickly as possible, and it was then possible to see that the mass consisted of a sac containing a fœtus and that

the placenta was implanted upon the posterior wall of the pelvis, the rectum, small bowel and omentum, extending more to the right than the left side.

The sac and as much placenta as possible were removed to control the hæmorrhage. A pack was then inserted into the pelvis, the end being brought out through the posterior fornix of the vagina. The peritoneum was sutured over the pack, and the abdomen closed.

The foetus was found to measure  $4\frac{3}{4}$  inches (12 cm.) from crown to rump.

During the operation the left tube and ovary were seen to be normal. The distal end of the right tube and the right ovary were obscured by adhesions and remnants of placenta.

Post-operative recovery was good, the pack being removed after forty-eight hours. Convalescence was delayed by a discharging abdominal wound and by bowel symptoms, which proved to be due to roundworm infestation.

#### COMMENT

The chief difficulty encountered during the operation was the profuse and sudden hæmorrhage from the placenta. It is usually considered to be safe to leave a "live" placenta undisturbed, and so avoid both the free bleeding and the possibility of damage to the blood supply of the intestines, should the placenta be fixed to the mesentery.

In the case reported, however, the hæmorrhage started before the true position, which appeared to be endometriosis, could be assessed, and the sudden collapse of the patient necessitated a sacrifice of the uterus in order to obtain an adequate exposure for hæmostasis.

It is difficult to decide whether the case was of a secondary abdominal pregnancy following a tubal abortion, or the more rare primary abdominal pregnancy.

A clear view of the right Fallopian tube and ovary was not obtained during the operation, as the placenta was implanted in an adjacent area, and the free end of the tube was surrounded by adhesions. It was not considered advisable to prolong the operative procedure.

The history of pain, starting as a colic in the lower right abdomen, would seem to suggest contractions of the Fallopian tube. A history of one month does not seem to be long enough, although a reliable and clear account was difficult to obtain from the patient. It is therefore suggested that the case was in fact one of secondary abdominal pregnancy continuing after a tubal abortion.

# REMEDIAL VISUAL FAILURE

BY

Lieut.-Colonel P. H. BALL

*Royal Army Medical Corps*

*British Military Hospital, Gibraltar.*

THIS is a brief report on two cases occurring in officers of the same service, same rank and same age group.

## 1. CAPTAIN—aged 41 years.

First referred on 2nd October, 1952, complaining of deterioration of distant vision in both eyes, of three days' duration. There were no other symptoms. At the onset, he found that he was unable to read, but this improved rapidly.

*Past History.*—Benign tertian malaria, 1945 (relapse); enteric (Burma), 1943. No head injuries. Never any similar attack and had never worn spectacles. Pulheems in May, 1952, showed his vision to be R. 6/6, L. 6/6.

*Habits.*—Smokes only three or four cigarettes daily and a pipe at week-ends. Drinks beer only, also at week-ends and then moderately.

*Examination.*—A large, healthy-looking man.

R.V. 6/18, L. 6/18.

Retinoscopy	R.	$\begin{array}{c}   \\ \hline \text{---} +1.75 \\   \\ \text{iii} \end{array}$	L.	$\begin{array}{c}   \\ \hline \text{---} +1.00 \\   \\ \text{iv} \end{array}$
-------------	----	--	----	---

No improvement by correction.

Pupils, active; corneæ, clear and sensation normal; media, clear; fundi, appear normal, with no definite abnormality of either disc, although both were considered somewhat paler than normal; fields, no scotomata.

*Investigations.*—Blood picture, normal; W.R. and Kahn, negative; urine, normal. Physical examination revealed no abnormality. Dental, clearance of all teeth in upper jaw recommended.

9th October: Admitted to hospital for dental treatment under general anæsthesia, with penicillin 200,000 units six-hourly.

14th October: Discharged.

31st October: R.V. 6/6-2. L.V. 6/9.

A considerable improvement.

8th June: R.V. 6/6. L.V. 6/6.

Considered to have returned to normal. This case was thought to be a toxic amblyopia, probably caused by dental sepsis.

## 2. CAPTAIN—aged 45 years.

Reported on 12th May, 1954, complaining that his vision with his present spectacles was failing. He had first noticed this about a month previously. He had worn glasses for many years, but his Pulheems showed that these corrected his vision to R. 6/9, L. 6/9 up to a year previously. There was nothing relevant in the past history, but on close questioning he admitted to smoking about  $\frac{1}{4}$  lb. "Navy Cut" pipe tobacco per week and drinking at least half a bottle of Spanish brandy per evening for past one and a half years. His consumption of alcohol had always been "rather heavy."

*Examination.*—Average physique, rather shaky and toxic looking.

R.V. 6/60

R.V. 6/24

with present glasses

L.V. 6/60

L.V. 6/36

		-2.00			-2.00
Retinoscopy	R.	—5.00		L.	—4.00
		i			ii

No improvement could be effected with any change of his present lenses.

There were no relevant signs in either eye, the tension and fundi being normal. Visual fields were not recorded, but the confrontation method revealed no gross abnormality.

*Investigations.*—Blood picture, normal; urine, normal; dental, slight marginal sepsis. At first consultation a firm diagnosis of tobacco/alcoholic amblyopia was made and the patient informed that he must stop both smoking and drinking at once, and completely.

19th May: Vision unchanged. Tells me that he had stopped his habits as advised.

23rd June: R.V. 6/12+ L.V. 6/18+ A marked improvement.

28th July: R.V. 6/6+ L.V. 6/12, a continued improvement.

Reading glasses were prescribed on account of presbyopia and shortly after this the officer was reverted to home establishment.

## SUMMARY

Two cases are recorded of defective visual acuity in officers of the same age group, of different origins, and both restored to normal or nearly so.

**LIEUTENANT-COLONEL P. DWYER,  
M.C., M.Sc., M.B., D.P.H.**

COLONEL DWYER died suddenly at his home in Dublin on 28th February, 1955, at the age of 73. As his qualifications show, he had a distinguished career as a student in the Royal University, Dublin, and joined the R.A.M.C. in 1907 or 1908. During the retreat from Mons he was captured at Landrecies, but escaped within a fortnight and returned to France a few days later. He was then employed at G.H.Q. until 1916. During this period he was closely associated with the development of schemes for the evacuation of sick and wounded and with the organization and equipment of Motor Ambulance Convoys and Ambulance Barges. In association with Lyle Cummins he devised the first gas-mask used by our troops and for some months prior to the formation of the Gas Corps he acted under the immediate direction of Sir Neville Macready for gas defence. He succeeded Lyle Cummins as D.A.D.M.S., H.Q., B.E.F.

In June, 1916, he accompanied Major-General T. J. O'Donnell on his appointment as D.M.S. India, and spent some time *en route* on inspection duty in Mesopotamia. He was appointed A.D.M.S. Peshawar, and among other activities was responsible for the great extension of hospital accommodation required for the casualties from Mesopotamia. He was also responsible for the medical arrangements for the Frontier expedition based on Quetta in 1917. For his services during the war he was awarded the M.C. and bar. On his arrival home in 1919 he was attached to the 5th Division at the Curragh and later became A.D.M.S. Dublin during the evacuation of Ireland. He subsequently became A.D.H. at Headquarters, Southern Command, where he took a great interest in the early development of mechanical warfare. He retired from the service in 1931.

On the outbreak of the Second German War he immediately offered his services and was posted as O.C. Military Hospital, York. He was not only a most successful administrator, but this post gave him an opportunity to resuscitate his dormant clinical talents, and many a distinguished consultant *en route* to other theatres of war learnt much from his clinical acumen. He took the keenest interest in his staff and patients and organized regular clinical meetings which were a great stimulus to all who served in York. He was loved by all who knew him closely and, when ill-health compelled his retirement in 1943, the officers under his command presented him with a Georgian loving cup as a symbol of their esteem and affection. Even after his retirement, many of them on leave enjoyed the hospitality of his beautiful home at Stillorgan near Dublin.

He had always been a keen and successful gardener, regularly exhibiting and winning many prizes at the R.H.S. After a period of ill-health he made a good recovery, and with characteristic energy developed one of the most beautiful gardens in Dublin. It was full of treasures which he gladly shared with his

friends. He showed only once in London after the war, winning several second prizes. In Dublin his entries always figured in the premier award lists. He had long been on the Council of the R.H.S., Dublin, and in 1953 became the Honorary Secretary. A short time before his death he prepared a new constitution for it.

His passing will be mourned by all who served with him and by many gardeners throughout Great Britain and Ireland.

PETER KERLEY.

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### Correspondence

*From Sir Jameson Adams, K.C.V.O., Hon. Appeals Secretary,  
King Edward VII's Hospital for Officers.*

15 ORMOND YARD,  
DUKE OF YORK STREET,  
LONDON, S.W.1.

*February, 1955*

DEAR SIR,

Will you once again allow me, through your JOURNAL, to call attention to King Edward VII's Hospital for Officers (Sister Agnes'), Beaumont House, Beaumont Street, W.1.

The extension, which we opened last January, has indeed proved its worth, as 538 Army officers were received as patients during 1954, of whom sixty-three were Serving Officers who, as you know, are entitled to free nursing and maintenance in the shared rooms.

The Samaritan Fund, which we started in 1952, has again proved its usefulness and was encroached upon to the extent of nearly £2,000 during last year. I think it is generally agreed that our work is meeting a vital need.

As is known, this Hospital has been disclaimed by the Minister of Health and is therefore entirely dependent on voluntary support. Subscribers, who are entitled to special rates, are asked to pay £1 yearly by bankers' order, which can be obtained from the Honorary Appeal Secretary, 15 Ormond Yard, Duke of York Street, S.W.1, who will also be pleased to receive very much needed donations.

All officers, serving and retired, permanent and temporary, are eligible for admission.

Yours very truly,

J. B. ADAMS.

## *Matters of Interest*

### PAPERS BY R.A.M.C. OFFICERS

- Baird, Lieut.-Colonel J. P., Morrison, Lieut.-Colonel R. J. G., and Roy Ward, Colonel W. : Discussion on Some Aspects of Ankylosing Spondylitis, *Proc. Roy. Soc. Med.*, 1955, 48, 201-210.
- Kirby, Captain N. G. : Sodium-nitrate Poisoning Treated by Exchange Transfusion, *Lancet* (1955), 2, 594-595.
- Mackay-Dick, Lieut.-Colonel J. : Nursing and the Tuberculous, *Nursing Mirror*, 25th February, 1955, pp. 1,449-1,450.
- Mitchell, Major P. C. : Tuberculosis verrucosa cutis among Chinese in Hong Kong, *Brit. J. of Dermatology* (1954), 66, 444-448.

### WOOLWICH SEARCHLIGHT TATTOO, 1955

THE third Woolwich Searchlight Tattoo will take place at Woolwich Stadium, London, from 21st to 24th September, 1955, at 7.30 p.m. each evening, with a special daylight performance at 2.30 p.m. on Saturday, 24th September. This year's programme promises to be even more spectacular than the previous year.

Among the items already booked are the Herald Trumpeters and Massed Bands of the Royal Regiment of Artillery, under the baton of their new Director of Music, Captain S. V. Hays ; the Trumpet and Bugle Band of the Boys' Regiment, R.A. ; the full Musical Drive of the King's Troop, R.H.A.—this is one of the few occasions when the full drive can be seen, ending with their ceremonial guns being fired. For the first time there is to be a contribution from the Territorial Army. There will be a Jeep Assembly Display by R.E.M.E. This was one of the high-lights of the 1953 Tattoo. New to Woolwich is a Motor-cycle Display by an R.A. Training Regiment. Once again the "Fourth Arm" will be represented in a dramatic and spectacular display by the Civil Defence Corps. The American Artillery and the United States Air Force will be providing displays and will be accompanied by their own bands. The programme is not yet complete and there will be a further announcement of other items taking part. The proceeds of the Tattoo go to the Royal Artillery Charitable Fund.

Tickets may be obtained from the Tattoo Box Office, Artillery House, 58 Woolwich Common, London, S.E.18 (Tel. : WOO. 1494), and all the usual ticket agents. Prices for covered seats are 15s., 12s. 6d., 10s. 6d., 8s. 6d., 7s. 6d., 6s. ; reserved uncovered seats 5s. ; unreserved seats 3s. 6d. There is a party concession rate for performances on 21st, 22nd and 23rd September for parties of 20 or more, also further reductions for the special daylight performance on 24th September. Details may be obtained from the Tattoo Box Office. Postal application for seats should be accompanied by remittances and a stamped addressed envelope.



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To fight a major foe of fighting men !

M. B. H. RITCHIE.

(Colonel Ritchie wrote this sonnet in 1927, "when the Corps was full of discontent," but it has never seen the light until now. Colonel Ritchie retired from the Corps in 1930, but in the 1939-1945 war he commanded successively the 8th Bn. The Seaforth Highlanders and the 6th Bn. The Cameron Highlanders, and then spent some four years as O.C. Troops in various transports.)

## R.W.A.F.F.

ALL officers and ex-officers who have at any time served with the Royal West African Frontier Force are reminded of the existence of the R.W.A.F.F. Dinner Club. A reunion dinner is held annually in London, that for 1955 taking place in October and for 1956 probably in May. The type of commission held by an officer or ex-officer (*i.e.*, regular, short service, emergency, N.S., etc.) is immaterial, the sole requirement of membership being service with West African troops in any part of the world. Further particulars may be obtained from the Hon. Secretary, R.W.A.F.F. Dinner Club, Bisterne, Normandy, Nr. Guildford, Surrey.

## *Book Reviews*

THE MEDICAL ANNUAL, 1954. Editors, Sir Henry Tidy and R. Milnes Walker.  
Bristol : John Wright & Sons. Pp. xiv+533, 67 pl., 32 illus. 32s. 6d.

The sub-title to this volume—"A year book of treatment and practitioner's index"—is misleading, for this work provides annually a review of the most recent developments in all branches of medicine and surgery and includes far more than a summary of treatment alone.

The bulk of the work consists of a collection of abstracts by some forty contributors, all well known in their respective fields. The ground they cover is extensive, and includes recent progress in all branches of medicine and surgery besides developments in radiotherapy and radio-diagnosis, obstetrics and gynaecology, anæsthetics, occupational health, preventive health and vital statistics. A barrister-at-law writes on medico-legal decisions and legislation and there is a long contribution on veterinary medicine.

There is considerable variation in the length of the abstracts and this has, inevitably, resulted in some lack of balance in the work as a whole. For example, eighteen pages are devoted to veterinary medicine and six to conjunctivitis, whereas hypertension is covered in less than two pages and congenital heart disease is dismissed in three paragraphs. This is because contributors vary in their method of presenting the facts. Some confine themselves to the bare bones of the published work ; others allow themselves a word or two of explanation or even of personal opinion ; others again, taking the bull by the horns, refer in the briefest terms to the published work and contribute papers of their own.

How best to present the year's work must remain a matter for controversy. It depends so much on what the reader wants. Those in search of full references, who are preparing papers of their own perhaps, will go for the brief abstract, unadorned by personal comment and with an extensive bibliography : others who wish rather to refresh their minds of what they have forgotten or missed will prefer the more personal account by an authority on the subject, and the references need not be complete. In this volume examples of both methods will be found, together with many variations between the extremes, and although most contributors confine themselves to the shorter abstract there are several very readable papers of the longer sort, notably Professor Boyd's on Intermittent Claudication and Dr. Meadows' on Cerebral Angioma and the Carpal Tunnel Syndrome.

The abstracts are arranged in alphabetical order so that "Chicken Pox" will be found sandwiched between "Christmas Disease" and "Cervix in Labour," and "Tetanus" separates "Tapeworms" and "Threadworms." This arrangement is presumably for ease of reference, but it as stands the book has a curiously disjointed appearance and a more formal grouping according to the systems involved would certainly add to the balance of the work as a whole.

However, it is not as a balanced account of recent progress that this work must be judged but as a reference book to the previous year's work, and as such it is very satisfactory, for the index is good, the ground is well covered and the references are full if not always exhaustive. The service doctor will be disappointed to find so few tropical diseases mentioned and there are one or two other omissions. No reference could be found to the method of positive-pressure breathing in the treatment of bulbar poliomyelitis, nor to the use of Isoniazid in the treatment of tuberculous meningitis. Nothing was said of the newer repository penicillin preparations, and the antibiotics as a whole were not accorded the privilege they surely deserve these days of a contribution to themselves.

But these are minor criticisms of what is a very good reference book. It is not recommended for every service clinician's book-shelf, but it should certainly be included in the annual additions to every hospital library, more especially those overseas where, owing to difficulty of access to published work, it is almost impossible to keep up to date with the latest developments.

S. E. L.

BULLETIN OF THE WORLD HEALTH ORGANIZATION : VOLUME 10, No. 5 (1954),  
RABIES. (Geneva : 10s.)

This symposium is divided into sections on virus research, the control of rabies in animals and the prevention of human rabies, and is a collection of papers given at the International Congress of Microbiology at Rome in 1953 on recent advances in the subject. Laboratory techniques are dealt with in a separate publication.

The use of eggs for the propagation of virus has made advances possible in the study of the virus and in the preparation of vaccines. The effectiveness of vaccines in the prophylaxis of rabies in dogs is discussed, and it is suggested that mass vaccination of dogs has brought about great reductions of the incidence of the disease in two countries. An interesting sidelight on this is the attitude of the German authorities who decided that, in the outbreak in their country, mass vaccination of dogs was not a suitable method of control owing, among other things, to the fact that the disease was most prevalent among wild animals. The situation is discussed with reference to N.W. Canada, where the disease is being attacked by reducing wild life population, controlling movement of dogs, and vaccination of dogs and cats in settled areas.

There are reports of trends of research on prophylaxis of human rabies in different centres using hyperimmune serum and various vaccines. The treatment of wounds caused by the bites of rabid animals is dealt with in two papers. A plea is made for development of a vaccine for human use which contains no brain, in order to eliminate neuromuscular complications of vaccine treatment.

In the final paper, Professor Karl Meyer attempts to answer the question, "Can man be protected against rabies?" and concludes that he can, provided that all resources, including canine mass vaccination and education of the population, are fully used.

R. J. C. H.

**BROMPTON HOSPITAL REPORTS**, Volume XXII (1953). Printed in England by Gale & Polden Ltd. Price 15s.

These reports are always a mine of information for all members of the profession and not only for specialists in intra-thoracic medicine and surgery. This volume is one of the best, containing as it does authoritative articles by such distinguished men as, for example, F. H. Young (Present Status of Lung Resection for Pulmonary Tuberculosis); Sir Clement Price Thomas (Carcinoma of the Lung); Dr. J. G. Scadding (Chronic Lung Disease with Diffuse Nodular or Reticular Radiographic Shadows); Sir Russell C. Brock (Valvotomy in Pregnancy); and G. Simon (The Lateral Position in Chest Tomography).

While it is agreed that the results of lung resection for pulmonary tuberculosis depend in large measure on selection of cases, which is improving month by month, surely the technical skill of the surgeon is always of paramount importance. On the latter depends materially the results of the post operative management. Furthermore, the long-term results must depend, in addition, on the time of operation together with the duration and total quantity of anti-bacterial drug therapy before and after operation.

Surely brucellosis is not just a condition with acute symptoms? What about chronic brucellosis?

The article on intra-thoracic lipomata fails to mention that many mediastinal lipomata are in fact lipothymomata, of which there are at least three distinct histological types. The case of moniliasis emphasizes that modern antibiotic drugs are not only dangerous to germs. They can and do bring death to those in whose aid they have been initially prescribed. "Licensed to kill" has more significance today than ever before.

The report on Bronchial Carcinoma (1951) is depressing reading, and makes the need of early diagnosis more imperative than ever. If only to give a patient a less unpleasant end, some authorities now consider that when operation is technically possible a lung carcinoma should be removed even in the presence of extensive metastases. Anyone who fails to read these reports must be on a desert island—if not, he should be.

J. M-D.

**PHYSICAL SIGNS IN CLINICAL SURGERY**, 12th Edition. By Hamilton Bailey, F.R.C.S., and Allan Clain, M.B., F.R.C.S. Bristol: John Wright & Sons Ltd. Pp. 466. 38s. 6d.

First published in 1927, this book has made a place for itself in the library of the student and postgraduate. While it can never replace clinical training, the 681 illustrations, many in colour, give excellent visual teaching and the subject matter has been brought up to date by the authors.

It should especially appeal to those young surgeons of the Corps serving abroad who are cut off from a university and its clinical material and who are studying for higher surgical degrees.

C. M. M.

THE DIAGNOSIS OF THE ACUTE ABDOMEN IN RHYME. By Zeta. 3rd Edition. London : H. K. Lewis & Co. Ltd. Pp. viii+96. 7s. 6d.

We agree with the author that "It is a way of learning without tears," for this little book of rhymes, punctuated with amusing line drawings, will teach you all about the acute abdomen.

C. M. M.

MANUAL OF MEDICAL HELMINTHOLOGY. By C. J. Hackett. London : Cassell, 1954. Pp. 310, and an index containing charts. 18s. 6d.

An excellent handbook on this specialized aspect of parasitology. It is well divided up and is most easily read. It contains brief remarks on diagnosis, treatment and prevention as well as the more detailed helminthology.

It assimilates admirably the more lengthy material from larger works into a form easily digestible by a candidate for such examinations as the D.T.M. and H., who has reached the revision or pre-examination stage and wishes to condense his reading.

Although containing somewhat more than is needed, it is nevertheless recommended for both Senior and Junior Officers' Courses at the R.A.M. College.

L. R. S. M.

BIOCHEMICAL INVESTIGATIONS IN DIAGNOSIS AND TREATMENT. By J. D. N. Nabarro. Pp. x+299, 5 illus. (including 1 plate). London : H. K. Lewis & Co. Ltd. 25s. net.

A clear understanding of biochemistry is becoming increasingly necessary for the practice of medicine. Though said to be written for hospital residents and registrars, this book should have a wider circle of appreciative readers as it covers fluid and electrolyte balance, mineral metabolism, and disturbances of protein, carbohydrate and fat metabolism, as well as the vitamins and certain types of poisoning. The emphasis is on clinical application rather than on laboratory methods, technical details of which have been deliberately omitted. The lists of references, the tables of normal values and the full index divided into available investigations and lists of abnormal conditions, diseases and treatment, help to make it an outstanding work of reference.

W. R. M. D.

A SYNOPSIS OF MEDICINE. 10th Edition. Sir Henry Tidy, K.B.E., M.A., M.D., B.Ch., F.R.C.P. Pp. 1,265. Bristol : John Wright & Sons Ltd. 35s.

A new edition of this well-known synopsis calls not for a review but rather for a reminder that such an up-to-date store of knowledge is so readily available. The main sections have been thoroughly revised, and the chapters on blood diseases, endocrinology and cardiology wholly or partly rewritten. For those who require a textbook of modern medicine for quick reference this book with its comprehensive index will prove invaluable.

W. R. M. D.

**PROGRESS IN NURSING.** Edited by Alan Moncrieff, *C.B.E.*, M.D., F.R.C.P., and Kathleen A. B. Fowler, S.R.N., S.C.M., R.C.S.N., D.N.(*London*), B.N.(*McGill*). Pp. viii+269, 27 figs. 1954. London: Edward Arnold (Publishers) Ltd. 18s.

Written primarily for the nursing profession, this work covers a wide range of subjects in both general medicine and surgery. For those nurses keen to keep in touch with modern developments this team of contributors has written a nursing textbook second to none. Midwifery has been purposely omitted. This summary of modern nursing can be recommended with confidence.

W. R. M. D.

**LIFE IN OUR HANDS.** By Pamela Bright. London: MacGibbon & Kee, Ltd. 1955. 12s. 6d.

A readable book by a nursing sister about a busy C.C.S. of the Second Army in Europe. The picture is a little overdrawn.

C. M. M.

**TEACH YOURSELF BIOCHEMISTRY.** By P. H. Jellinck, B.A., M.Sc. London: The English Universities Press Ltd. 1953. Pp. 199. 6s.

This little book can be well recommended to those seeking an introduction to biochemistry and also to the student wishing to make a quick revision of the subject. Unlike many books of this nature, it is easy to read and the author has succeeded in his aim to present the subject in a clear and very simple manner.

E. G. H.

**CLINICAL BACTERIOLOGY.** By E. Joan Stokes. Pp. vi+288, illustrated. London: Arnold. 1955. 20s.

This book approaches bacteriology from the standpoint of the hospital laboratory. The technique of handling every type of bacteriological specimen is dealt with so as to produce the most valuable result to the clinician in the shortest possible time. Every technique is described in detail and care is taken to show the pitfalls which may beset the way of the unwary. Of necessity, so small a book can contain only the smallest amount of theoretical information, but this has been carefully selected. For example, enough systematic guidance is given to enable the tyro struggling with a difficult organism to know where to look in the larger textbooks in order to complete the process of identification. The book abounds in clearly worded descriptions of the techniques used in the author's laboratory, illustrated with excellent diagrams. The final chapter on "Media testing and other techniques" contains much useful information, but its value would be enhanced if some notes on cleaning and sterilizing laboratory utensils were added. There is a very small crop of errors missed by the proof-readers, including the mis-spelling of Leishman's name on page 38. In the chapter on the bacteriological investigation of *fæces*, no mention is made of the value of selecting pieces of mucus for culture, the diagram of the Craigie

tube shows a square bottom end instead of the bevelled end which is necessary for the free outgrowth of organisms, and Table XI leaves one with the impression that all types of *Shigella flexneri* produce indole. Since the use of dyes in the identification of *Brucella* is mentioned in a table, it seems a pity that the technique is not mentioned in the text.

This excellent little book is an essential part of the armamentarium of the trainee pathologist and can be read with advantage by experienced bacteriologists. In addition, the chapter on hospital epidemiology is a masterly exposition of the subject and all who have clinical charge of hospital wards would do well to read it. The book is well printed and bound, and is excellent value for money.

R. J. C. H.

UNDER THE LASH. By Scott Claver. London: Torchstream Books. 1954. Pp. 288, illustrated. 21s.

This book is described as a history of corporal punishment in the British Armed Forces and is compiled largely from contemporary publications and records, from which the author has borrowed heavily. Although the largest sections of the book are devoted to methods of flogging, other curious and rather horrible punishments, including the Whirligig, the Strappado, Kissing the Gunner's Daughter, and Tongue Boring, are described. The frequency of sentences of up to fifteen hundred lashes with the military "cat" and, for the sailor, "flogging around the fleet" demonstrates with what almost incredible severity discipline in the Services was maintained only a hundred years ago.

Of greatest interest, perhaps, are the extracts of the work of the Royal Commission of 1835-6. It is clear from its findings that military punishments of those days were inflicted primarily with the purpose of deterring from military crime those who had perforce to witness them, the reform of the flogged offender being of secondary consideration. This fact explained the reluctance on the part of the authorities to substitute for public floggings other punishments, such as solitary confinement, which being essentially private lost its deterrent efficacy for others. It is interesting to read that the Duke of Wellington and others of high integrity and humanitarian sense were adamant that discipline could not be maintained in an army without the punishment of flogging, arguing that nothing else would subdue the soldier of low character, vicious disposition and degraded habits—men so frequently enlisted under the voluntary system then operating.

The necessity for measures to improve the standard of recruitment and "moral discipline" of the Army were seen clearly enough by the Commission and included better pay, better barracks, the provision of libraries, reading-rooms and playing-fields. The military reader will note somewhat ruefully that this vision was discarded with the words "the increases (in pay and improvements) must go to an extent which we cannot contemplate and which would make the expense of the Army so burdensome as would not be borne by the Country"—now traditional Treasury sentiments!

While the book contains much of interest to anyone concerned with military matters, there is over-all a surfeit of detailed and bloody floggings that will tend to reduce the reader to a state of æsthetic numbness in much the same way as the unfortunate offender was often (we read) reduced by prolonged punishment to a state of physical insensitivity. For this reason the book is likely to have other and less legitimate appeals than those that attract a student of military history.

J. F. D. M.

The following have also been received :

Bilharzia Snail Vector Identification and Classification. W.H.O. Tech. Rep. Ser. No. 90. London : H.M.S.O. 1954. Pp. 22. 1s. 9d.

The Administration of Nursing Services : Third Report of the Expert Committee on Nursing. W.H.O. Tech. Rep., Ser. No. 91. London : H.M.S.O. 1954. Pp. 28. 1s. 9d.

Poliomyelitis. W.H.O. Monograph Series No. 26. London : H.M.S.O. 1955. Pp. 408. 40s.



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Original articles, notes and letters bearing upon either the medical or the military aspect of the work of the Corps will be gladly received. All papers intended for publication should be typewritten (*not* duplicated), double-spaced and fully corrected. Proofs are not sent to authors serving out of the United Kingdom.

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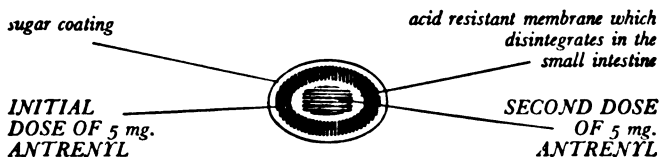
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## Journal

THE

## Royal Army Medical Corps

ISSUED



QUARTERLY

EDITOR

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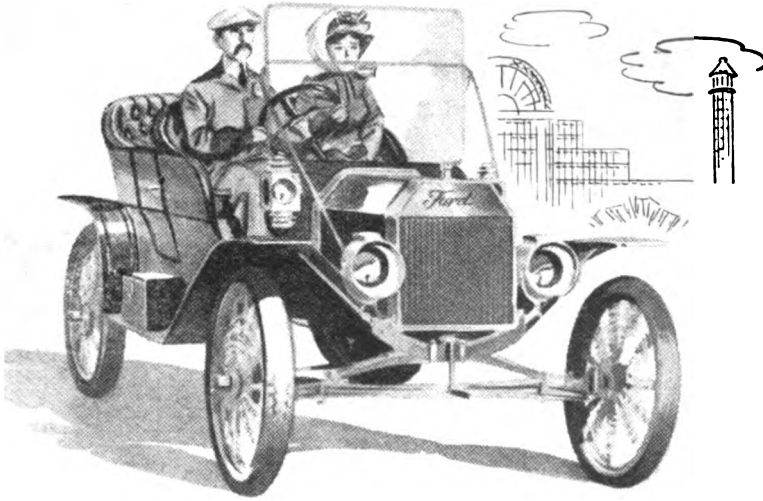
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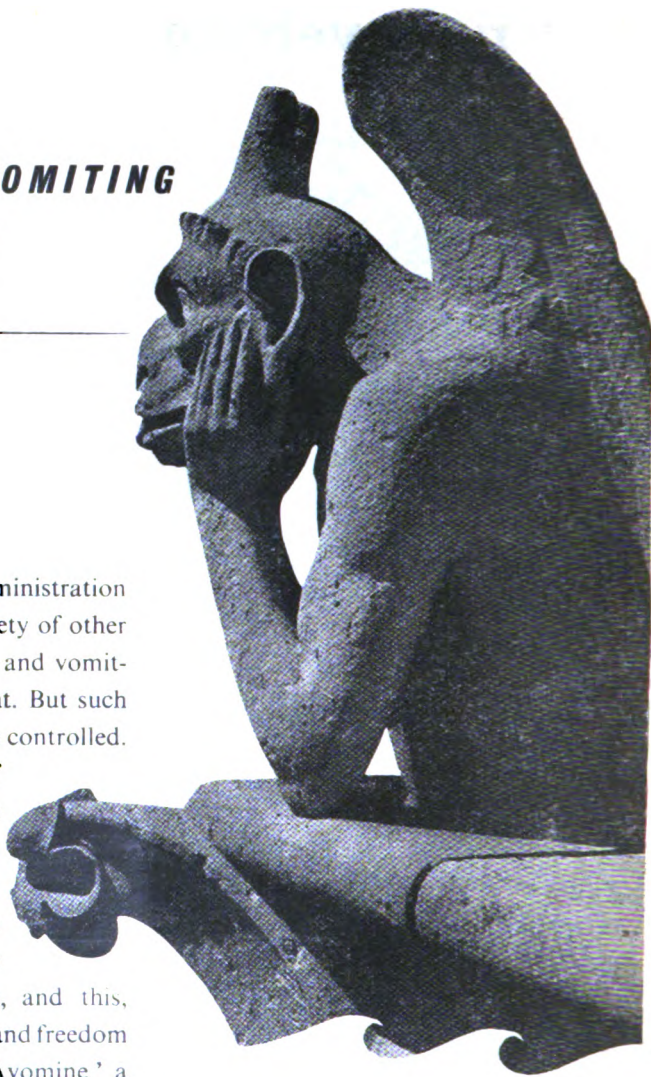
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# Journal of the Royal Army Medical Corps

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## *Original Communications*

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### CLINICAL MATERIAL CONCERNING BURNS RELEVANT TO NUCLEAR WARFARE \*

BY

PATRICK CLARKSON, F.R.C.S.

*Casualty Surgeon in charge, Children's Burns Unit, Guy's Hospital  
Hon. Civilian Consultant in Plastic Surgery, the Queen Alexandra and the Cambridge  
Military Hospitals*

#### REVIEW OF THE PROBLEM

THE diagrammatic sheets reproduced here are intended to indicate current treatment of burns, especially those aspects of special relevance to the Army problem in war time. The subject of burns is a diffuse and complex one. Nor is there general agreement on some aspects of treatment. I have therefore started with certain charts dealing with pathology in order to provide a comprehensible background, both to the rather over-simplified treatment I have recommended and to possible future therapeutic developments. In case there is anything dogmatic about the manner of this presentation, I think it is worth while reminding ourselves now in 1955 that it is only fourteen years since we, the profession as a whole, endorsed the local treatment of burns by tannic acid—a method responsible for crippling many hands and, indeed, for many deaths, as compared with the results obtainable by other methods available at the same time. It is certain that some of the recommendations which are made here, and which I believe to be generally acceptable today, will be replaced in the none too distant future; but I do not believe that any will fall into the disrepute associated now with the tannic acid treatment.

---

\* Based on a paper read at the D.G.A.M.S. Exercise "Avernus," October, 1954.

The burns we have to consider are chiefly those occurring in young fit men of eighteen to thirty years of age. I describe the details of their treatment in the collecting zones and in the first few days in the holding zones, but only indicate the principles of their later treatment until healing.

We can expect in any future war that the great majority of burns will be the results of nuclear explosions. That is they will be chiefly flash burns of exposed parts of functional importance (*i.e.*, the hands and face); they will be of up to 10 per cent. body surface in area, chiefly superficial but in parts deep; and most will not need intravenous infusion. There will, of course, also be many burns from secondary fires which will affect the body extensively. In addition there are to be considered battle burns from conventional weapons (explosions in tanks, phosphorous grenades, napalm bombs, cordite explosions); and accidents with petroleum products can be expected to continue to provide a steady source of seriously burnt soldiers in any future war, as they did in the recent one. The soldier who cleans his battledress or denims with petrol while smoking a cigarette, or who improvises with petrol for cooking or heating, is likely to be always with us and always a serious casualty, making excessive demands on medical services and supplies.

It is the extent of burnt area which chiefly determines the need for intravenous infusion. Ideally, burns with 15-20 per cent. of the body surface involved should be infused with colloid and electrolyte solutions. In practice, intravenous infusion may have to be reserved for burns of 30 per cent. of the body surface burnt, and greater; but when the soldier is cold and has in front of him a long evacuation there will be additional deaths in the 20 per cent. group unless they are infused. Dilute plasma is lost from the circulatory system in proportion to the area burnt and the maximum rate of loss is within eight to twelve hours of being burnt. (A patient burnt 30 per cent. of the body surface may lose up to 30 per cent. of the circulatory volume in eight to twelve hours.) The time within which intravenous infusion is essential, before an irreversible condition is reached, is therefore of great importance; this also varies with the percentage of the body surface burnt. It is probably possible to leave most 30 per cent. surface burns for eight to twelve hours without greatly increasing the mortality rate in young soldiers; but if they are cold and subject to evacuation, this period will have to be reduced to three to six hours or there will be extra deaths. Burns of 50 per cent. of the body and over need infusion at the earliest possible moment, but those who are going to live probably do not reach an irreversible state in less than two to four hours, unless cold and subject to evacuation. An acceptable replacement programme for the fluid, electrolyte, and colloid loss from the circulatory system is 1 litre or about 2 pints (1 litre =  $1\frac{1}{2}$  pints) of 5 per cent. dextran-normal saline solution per 10 per cent. body surface burnt, with a total limit of 12 pints in the first two days.

Depth is also of great importance in burns. A deep burn has a greater early and late mortality than a superficial burn of equal extent. It is in deep burns that there is considerable red cell loss (a deep 50 per cent. body surface burn may

lose nearly half the red cell volume in the first few days). Deep burns therefore need early blood as a big percentage of their total colloid infusion. The chief other fact of importance about depth is that it determines the prognosis for local function and the need, or otherwise, for slough excision and grafting.

Local treatment in the collecting zone is principally by cover with the Universal Dressing. There may be a valuable role also for a topical analgesic and antiseptic creams. As soon as the casualty can be held, most burnt areas, except the hands, are best treated by exposure. But whether dressed or exposed, it is essential to maintain burnt hands in the position of function, and the feet dorsiflexed. If the burns are to be covered by dressings they will first need a toilet under analgesia ; if treated by exposure a toilet is not necessary unless the affected areas are soiled.

The healing phase after the first week is mainly concerned with early slough removal and early resurfacing, but other major aspects of treatment are the maintenance of nutrition (chiefly by concentrated milks and vitamins), and in the deep burns, correction of the persistent anæmia by transfusions.

#### PATHOLOGY

Chart 1 illustrates the well-known fact that the flash burns that we have to consider are only one of the biological effects of electro-magnetic radiations. The generalization is broadly true that the shorter the wave length of the radia-

## BIOLOGICAL EFFECTS OF ELECTRO-MAGNETIC RADIATIONS THE SPECTRUM

<i>Y-Rays</i>	<i>X-Rays</i>	<i>Ultra Violet</i>	<i>White light</i>	<i>Infra Red</i>	<i>Radar &amp; Wireless</i>
<b>WAVELENGTH</b> <b>0.001</b> <small>ANGSTROM UNITS</small>	<b>0.1-100</b> <small>A.U.</small>	<b>2000-4000</b> <small>A.U.</small>	<b>4000-10000</b> <small>A.U.</small>	<b>10000</b> <small>A.U.</small>	<b>1 mm →</b>
<b>CLINICAL EFFECT</b>	<b>D.I.I. →</b>	<b>SKIN BURNS</b>			<b>N.B.</b>
<i>Diffuse Ionising Illness (D.I.I.)</i>	<i>Skin burns Vesicles in 1-2 days lasting 3-5 weeks</i>	<i>Vesicles in 6 or more hours</i>			<i>MOST CIVILIAN BURNS ARE CONTACT (i.e. CONDUCTION) BURNS WITH VESICLES WITHIN MINUTES OF BURNING</i>
			<i>Vesicles within 1 hr. &amp; stopping at 42-48 hrs.</i>		

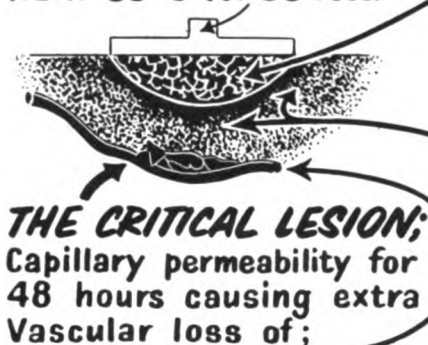
*The shorter the wavelength the longer the period before Vesication and the longer the period of Vesicle formation.*

CHART 1

# PATHOLOGY OF BURNS I THE LOCAL LESION

PETERS.

CRITICAL SOURCE OF  
HEAT 60° C for 60 secs.



**THE CRITICAL LESION;**  
Capillary permeability for  
48 hours causing extra  
Vascular loss of;

**WATER  
ELECTROLYTES  
COLLOIDS.**

*A possible effect of*

## ZONE I

*Proximal irreversible zone of  
heat coagulation whose depth  
determines local prognosis for  
function.*

## ZONE II

*Distal diffuse zone of reversible  
enzymic change whose extent  
determines prognosis for life  
in primary phase.*

*Enzymes possibly produced:-*

**HISTAMINE  
HYALURONIDASE  
PROTEINASE**

CHART 2

tions, the longer is the latent period before skin vesiculation and the longer the period of vesicle formation. Thus soft X-rays or beta particle contamination of the skin (as might be expected in "fall out" zones) cause vesicles in one to two days, and these vesicles continue to form for three to five weeks even in the absence of infection. Ultra-violet burns (2,000 to 4,000 A.U.) commonly take six or more hours to form vesicles. White light burns, *i.e.*, sunburn (4,000 to 10,000 A.U.), show vesicles in less. Infra-red radiations (10,000 A.U. and above) can produce vesicles in one hour or in a shorter period. The direct flash burns of a nuclear explosion are, in those in the zones in which survival is possible, chiefly caused by a mixture of white light and infra-red. This radiation from a 20 K.T. bomb at 4,500 yards on a clear day (visibility twenty miles) will, according to the work of Butterfield (1950), give about 3 calories per square centimetre on exposed skin and cause erythema which will appear within an hour. At 3,000 yards, under the same conditions, there will be about 5 to 6 calories per square centimetre on exposed skin; this will cause full thickness heat coagulation of the skin. It should be noted that 10 calories per square centimetre is sufficient to ignite clothing. Secondary fires, from burning clothing or from burning buildings, will be common and will account for many of the more extensive burns amongst survivors. These burns are, like the great majority of civilian burns seen today, contact burns, *i.e.*, conduction burns. In these burns vesicle formation is a matter of minutes. Indeed, in the scalded skin of a child they may appear and burst within a few seconds.

Chart 2 is adopted from that of Professor Sir Rudolph Peters. The concept of all burns as comprising two zones is a practical and useful one. The proximal zone is one of irreversible heat coagulation whose depth determines both the prognosis for function and the amount of red cell loss. The diffuse distal zone is one of reversible invisible enzymic change whose extent determines the early prognosis for life. There is synthesis or liberation of histamine, hyaluronidase, proteinase, and possibly other enzymes. The key pathological lesion produced by these enzymes in this area is excessive capillary permeability leading to loss of the non-corpuscular elements of the blood from the circulatory system, and hence to a fall in the circulatory volume which may be critical. Three elements—water, electrolytes, and colloids—are lost. This loss is only into the burnt area and in the blisters. The greater the area of burn, the greater the loss, the bigger the fall in circulatory volume, and the worse the prognosis. This outpouring from the circulation reaches a maximum in about eight to twelve hours. In the absence of infection it ceases in forty-eight hours, when there is a heavy lymphatic flow from the burnt area back into the circulatory system. For this reason it is generally best to restrict intravenous fluids at the end of the second day as the kidneys may already be taxed with the excretion of the returning lymph from the burnt area. There is increased danger of overloading the heart and lungs at this stage by intravenous infusions. In the œdema and blister fluid the protein is about 5 gm. per cent. (approximately what it is in a bottle of plasma); the electrolyte concentration is the same as that of plasma. These observations are the basis of therapy which aims at the replacement to the circulatory system of the calculated extra vascular loss of water, electrolytes, and colloids by formulæ based on the percentage body surface burnt.

Chart 3 has been modified from that given by Professor Thorn of Boston at the Washington Symposium in 1950. It presents an intelligible basis for the known fact that different people of the same age, and burnt to the same extent and depth, respond differently to the stress of the burn. This particularly holds for the most severe burns. Thus about half the patients with more than 50 per cent. body surface burnt given full orthodox treatment will die, while the other half treated in precisely the same way will survive. This fact is explained by the general term "constitution"; and general fitness is of manifest importance in the outcome. It is my view that the "thin wiry type" withstand the stress of severe burns better than most others do.

Thorn's chart also provides a background for future therapeutic developments. Although experience to date with cortisone has shown that this has no general value and is indeed often dangerous, nevertheless in a limited group, when there is clear evidence of adrenal failure, cortisone can be used. The role of the hepato-renal system, which responds both to the neuro-endocrine axis and to the local system of enzymes, is complex and still largely obscure. It is clear, however, that renal function is most important in determining the outcome in a large number of burns, especially in the older age groups whose mortality is so much more serious. We all start getting old at the age of thirty as far as our ability to withstand the stress of a burn is concerned, and we are really old by fifty.

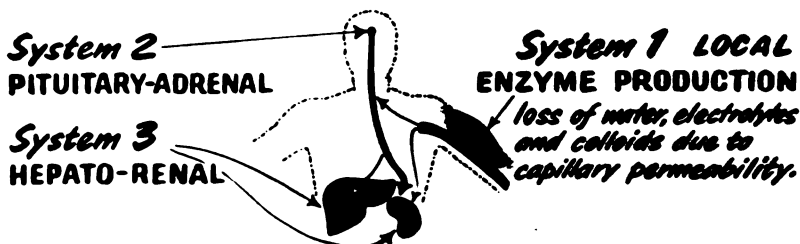


# PATHOLOGY OF BURNS

## II THE CONSTITUTIONAL RESPONSE

THORN

*There are 3 main systems involved in the Body's response to the stress of a severe burn.*



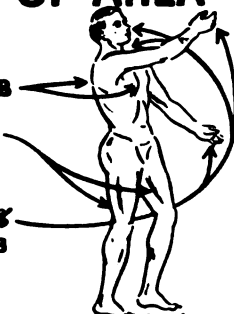
- 1 THE LOCAL SYSTEM (*enzyme production causing capillary permeability*)
- 2 THE PITUITARY-ADRENAL (*neuro-endocrine axis*) SYSTEM responding to System 1 according to capacity of patient to do so.
- 3 THE HEPATO-RENAL SYSTEM responding both to System 1 & 2 with Hypo- and Hyper-Tensinogens and Detoxifications.

3

CHART 3

## ASSESSMENT AND SIGNIFICANCE OF AREA (% Body Surface Burnt)

WHOLE TRUNK Front or Back	Less Than	40% B.S.B.
WHOLE LOWER LIMB	" "	20% "
" UPPER "	" "	10% "
" HEAD & NECK	" "	10% "
WHOLE BOTH HANDS & FRONT NECK & FACE	Less Than 10%	
" " HANDS		5% B.S.B.
FRONT NECK & FACE		5% "



*In assessing % B.S.B. only include areas of vesiculation & deeper, not skin showing erythema; the tendency is to exaggerate due to inclusion of soiled & erythematous areas.*

*I.V. Requirements of colloid & electrolytes are determined by % B.S.B. i.e. by aggregation of affected areas. (e.g. whole of one leg plus one arm, and some adjacent trunk = 30% B.S.B. whole of both hands plus face = 10% B.S.B.)*

*For young fit man I.V. colloid and electrolyte are indicated for 25%-30% B.S.B. and about 1 c.c. each of colloid and electrolyte solution may be indicated for each Kilo and each 1% B.S.B. e.g. 30% in 80 Kilo man. = 2400 c.c. each of colloid and of electrolyte solution each of first two days (upper limit 3000 cc. each per day) plus about 2000 cc. of oral fluids as the normal metabolic requirement. This oral fluid should have salt and bicarbonate in it. If it is of pure water it may cause water intoxication.*

CHART 4

## PERCENTAGE OF BODY SURFACE BURNT

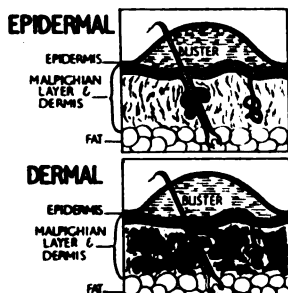
Chart 4 indicates in adults the percentage of the total body surface represented by different parts of the body, but it is a very modified Berkow scale. Many of you may prefer the "rules of nine" of Wallace. But I have always found it easy to remember that the biggest part of the body is the trunk and this adds up to nearly 40 per cent. of the total surface area of the adult body. Therefore the front or back of the trunk is something under 20 per cent. ; the next biggest part, the lower limb, is also something under 20 per cent. ; the next biggest part, the upper limb, is something under 10 per cent. ; the whole of both hands is 5 per cent. ; the front of the face and neck is 5 per cent. ; therefore burns of the whole of the hands and of the front of the face and neck are about 10 per cent. (but the common combination in flash burns is for the backs of both hands plus most of the face and some upper neck to be involved, which adds up to about 7 per cent. to 8 per cent. body surface burnt). It must be emphasized that only areas of vesiculation should be taken into account in assessing the total area (and hence both the prognosis for life and the intravenous colloid, and electrolyte requirements). Areas of erythema are not included. The common error is to exaggerate by including these and areas of soiling. It is therefore true to say that what is called initially a 30 per cent. body surface burn is likely on critical re-assessment to prove to be only 25 per cent. A useful check-up is to make an assessment not only of the burnt area but also of the non-burnt area, and to see that these two do indeed add up to 100 per cent. At the same time that the total body surface is assessed, attempts should be made to calculate what proportion of the affected areas are full thickness in depth, as depth adds considerably to the gravity of the prognosis, to the need for prompt intravenous fluids, and to the need for early blood.

## DEPTH OF BURN

Chart 5 describes the basis of recognition and the significance of depth. Partial skin loss burns heal from below up ; but it is important to recognize two degrees of partial skin loss—epidermal and dermal. In epidermal burns there is a viable Malpighian layer. Only the roof of the blister is heat coagulated. Healing occurs in one to two weeks without residual scarring or disability, and of course the disease is terminated by this time. Dermal burns involve punctate coagulation of areas of the dermis. These areas must separate, and final healing is slower. But again it is from below up, although it may take three to six weeks, depending on the thickness of the dermis. There is always some residual scarring and disability, which may need later plastic revision. In the deeper dermal burns it may only be the hair follicles or sweat glands which survive and which provide foci for healing. It may be impossible to distinguish this depth of dermal burn in the early stages from those with heat coagulation of the full thickness of the skin. Douglas Jackson has pointed out that the differential diagnosis of full thickness from deep dermal burns is dynamic, and may not be possible before the end of the second week when the superficial dermal slough begins to separate and show granulations of stippled appearance, due to surviving hair follicles

## SIGNIFICANCE AND RECOGNITION OF DEPTH OF BURNS

### I PARTIAL THICKNESS SKIN LOSS BURNS



#### HISTORY—

*Epidermal* that is with heat coagulation of epidermis only. These heal from below up in 1-2 weeks without scarring or disability.

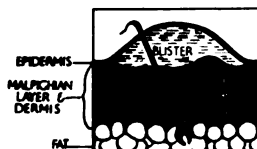
*Dermal* there is patchy coagulation of dermis. These heal 2-5 weeks from below up with scarring.

#### RECOGNITION —

Most scalds; most cordite and other flash burns. Atom flash giving 2-3 calories on skin is 4500 yds and over on a clear day are principally epidermal or dermal in depth.

They are painful burns, the blisters have reactive, sensitive bases. Slough separates in dermal burns in 3rd week leaving 'stippled' granulations.

### II FULL THICKNESS SKIN LOSS AND DEEPER BURNS



#### HISTORY—

*At Full Thickness Skin Loss* there is heat coagulation of all layers plus follicles. Healing of all layers of skin is from without in after slough separation and is of indefinite period depending on size, site, and grafting. There is always residual scarring.

Skin in contact with burning clothing. Flash burns giving 5-6 calories on skin is atom flash at 3000 yds on a clear day (BUTTERFIELD). Electric, and burns in unconscious, epileptic and trapped patients, are all chiefly full thickness in depth.

#### RECOGNITION —

Full thickness burns are less painful. Blisters have insensitive bases. Subcutaneous oedema is more marked. Later granulations are non-stippled.

CHART 5

## CLINICAL COURSE OF SERIOUS BURNS

### PRIMARY PHASE

*Of 7-10 days; of shock resulting in survival or exhaustion and death*

### SECOND OR HEALING PHASE

*From the second week of separation of dead tissues and of primary healing characterised by Anaemia & Negative N. Balance.*

### THIRD PHASE of Reconstruction and/or Rehabilitation

CHART 6

and sweat glands in islands of subcutaneous fat. Diagnosis of depth is also much helped by history. The full thickness of the skin is almost always heat coagulated, if the skin has been in contact with burning clothing, or if the patients have been unconscious or trapped in contact with a heat source, or if a white light-infra-red flash burn has given 5 or more calories per square centimetre to the skin. These deep burns are likely to be less painful, due to heat coagulation of pain filaments ; there is also likely to be a disproportionate amount of subcutaneous œdema under and around the burn.

### CLINICAL COURSE

All extensive deep burns may be said to pass through three phases (chart 6). The primary phase of shock and countershock lasts seven to ten days and results in survival or exhaustion and death. It is followed by a secondary or healing phase of separation of dead tissues and primary resurfacing. The third phase is that of rehabilitation and/or reconstructive surgery. The flash burns of the hand and face, which form the majority of the cases we are considering, will show little early constitutional or shock response. The burnt parts will at first, according to Butterfield (1950), be intensely painful, especially if not of full thickness in depth. This burning, smarting pain will last from a few seconds to two minutes and will then be replaced by a throbbing, aching pain which will pass off in about half an hour. After that the burnt areas will feel sore and be painful on movement, especially if touched or knocked. The more extensive secondary burns will develop constitutional signs in proportion to the area burnt. But it is most important to realize that even very extensively burnt patients are capable of considerable activity before developing gross signs of shock. Patients with 80 to 90 per cent. body surface burnt often remain active and very alert in mind for two to three hours or more ; and it is important to remember that the early as well as the late outlook for a deep burn is always more serious than a superficial burn of the same extent. Clouding of consciousness and delirium in a burnt patient are most serious signs and much more likely to be indicative of cerebral anoxia due to decreased circulatory volume and to acute electrolyte imbalance (possibly exacerbated by the taking of pure water by mouth), rather than pain. Intravenous fluids rather than opiates are indicated. Burnt patients as their condition deteriorates show : rising pulse rate, falling pulse volume, cold extremities, falling blood pressure, thirst, vomiting, restlessness, or apathy, and clouding of consciousness. This clinical course is fairly constant. They show response to treatment by change in the reverse order. Decreased urinary output is common and an indwelling catheter is often a useful guide to progress and to fluid needs. An excretion of 30-50 ml. per hour is desirable.

### MORTALITY

Charts 7, 8 and 9 indicate the mortality rates in two reasonably large series of burns. The figures collected by Lawrie and myself (1946), from soldiers in North Africa and Italy, relate only the percentage surface area of the burn to the

mortality. They show that in this age group (pre-eminently eighteen to thirty years) a 50 per cent. body surface (some deep, some superficial) has a 50 per cent. mortality. But it must be emphasized that the group included one soldier with 80 per cent. of the body surface burnt superficially who survived, and another of 75 per cent., of which nearly half was full thickness skin loss, who also survived. Surgeon Captain Beach, R.N. (1954), tells me that in a recent group of 35 extensively burnt naval casualties treated in Malta there were three of over 90 per cent. body surface burnt, and one of these survived. Bull's graph shows the Birmingham mortality rates related to age and to body surface burnt. I draw attention to the fact that in this large and most expertly treated series there is 10 per cent. mortality for 30 per cent. body surface burns in the eighteen- to thirty-year-old group. In the same age group the mortality for 50 per cent. body surface burnt is about 50 per cent. In considering the possible mortality rates in burns in nuclear wars we can expect a lower rate amongst soldiers than appears amongst civilians, even in the same age groups, and even allowing for the fact that a battle casualty has often been under stress, short of fluids for many hours, and subject to evacuations. Reasons for this view are that the training of the young soldier makes him better able to withstand the stress of the burn, and he is less liable to be suffering from independent illness or disability.

In the last five years there has been no dramatic improvement in the over-all mortality of extensive burns treated in Burns Centres. There was a big improvement about ten years ago due to prompter, more radical and better surgery, to antibiotics and to plasma. Some fresh development appears needed for any further marked improvement now.

# MORTALITY-I

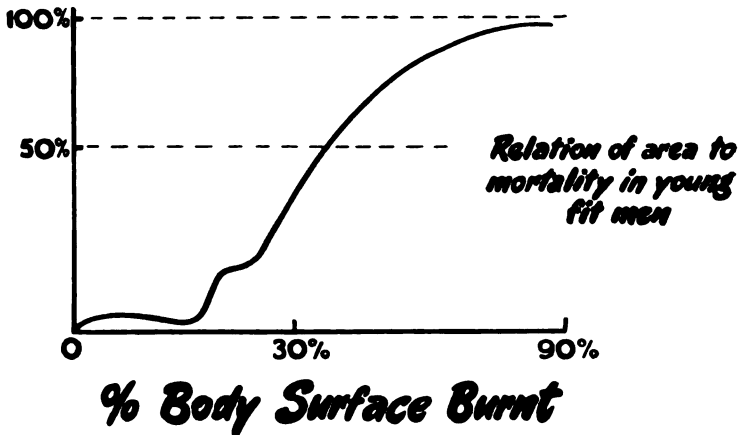
*The chief causes of death in burns are :-*

<b>I. SHOCK</b>	<b>70%</b>	<i>{ due to the fall in the circulatory volume of blood and to acute electrolyte unbalance</i>
<i>In first 10 days</i>		
<b>II. INFECTION</b>	<b>30%</b>	<i>{ The proportion of these deaths is rising in severe cases as early therapy becomes more successful</i>
<i>Combined with metabolic failure</i>		
<i>After the first week</i>		

CHART 7

# MORTALITY-II

**Clarkson and Lawrie 1000 serious burns  
(about 25% treated primarily; 20% grafted)**



**At 50% B.S.B. the mortality is about 50% for 18-30 year olds**

CHART 8

# MORTALITY-III

**BULL 2800 BIRMINGHAM M.R.C. BURNS**

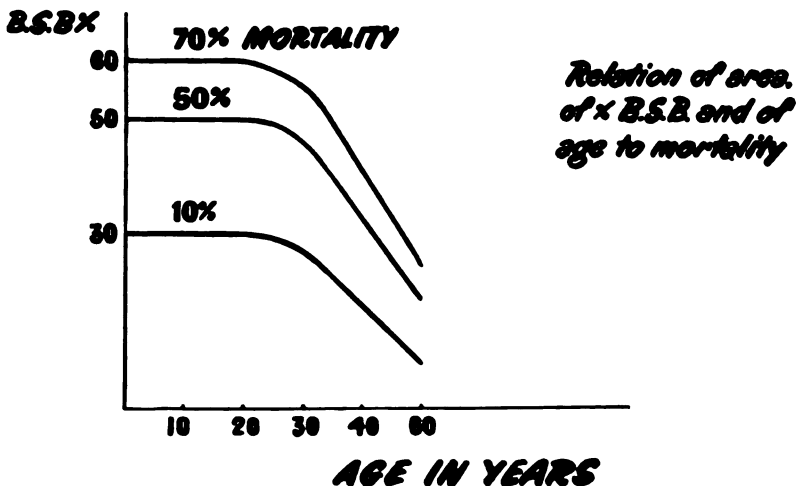


CHART 9

## TREATMENT

Charts 10, 11, 12, 13 and 14 indicate the principles and some of the techniques of treatment in the primary phase.

*First-Aid*

The first-aid treatment of the flash burn of the hand of a soldier in action is, I am sure, best done by the oilsilk bag. Burns of trunk and limbs may have their treatment by the Universal Dressing. My own view is that there is a strong case also to be made for the local application to flash burns of hand and face of an analgesic antiseptic cream, which a soldier could carry in his personal kit (a combination of a non-basic analgesic plus a detergent cream might be suitable).

Relief of pain is best by intravenous opiate. The subcutaneous route should always be avoided as its absorption may be delayed until another dose has been given. I believe that omnopon or heroin are preferable to morphia as they are less likely to produce vomiting; and they have, too, a greater "narcotizing" effect.

In extensive body burns the clothing should not be removed at the first-aid stage, but exposed burnt areas should be covered by the Universal Dressing. Exposure has no role in the collecting zones or during any evacuation of the patient. The only exception to this is the facial burn, although many of these are made most comfortable by covering with tulle gras (supported perhaps by a "tube gauze" outer cover).

The charts also indicate a scheme of intravenous colloid and electrolyte replacement. Schedules vary in different Burn Centres, but one of 5 per cent. dextran/normal saline solution (1 litre per 10 per cent. body surface burn with an upper limit of 6 litres in two days) is acceptable and has been found satisfactory at Basingstoke and elsewhere. High molecular dextran is a better plasma expander than plasma itself in the early treatment of burns. It is also without risk of causing jaundice (which Maycock has assessed as a 2 per cent. chance in the use of plasma). In all deep burns half to a quarter of the total colloid infusion is, ideally, blood. Some other workers prefer different proportions of electrolyte and colloid. The U.S. Army chart published by the Brooke Hospital, Texas, uses the formula of 1.5 c.c. electrolyte to 0.5 of colloid. The electrolyte solution used is a balanced electrolyte solution, such as lactated Ringer's solution; and there are theoretical disadvantages in giving normal saline solution in large amounts at a time when the body has a positive sodium balance. Whatever solutions are used it is very desirable that one-third of the forty-eight-hour infusion replacement programme be completed within the first eight hours after burning. Another third is given during the remainder of the first day, and the last third the second day. Burnt patients who have also been exposed to 100r or more of gamma radiation should have 50 per cent. of their colloid as blood (burns and gamma radiations go ill together, and very adversely affect the mortality of each). In addition to the intravenous infusions, the normal metabolic requirements of at least 4 pints of fluid a day in regular small amounts are given by

# TREATMENT OF BURNS

## PRIMARY PHASE

*Preservation of life by maintenance of circulation (Restoration of calculated extravascular loss; of fluid, electrolytes, and colloids)*

*Prophylaxis of infection by local care (note role of primary excision)*

## HEALING PHASE

*Surgical or chemical removal of dead tissues (complete by 2nd or 3rd week)*

*Surgical Resurfacing (complete for most cases by end of 6th. week)*

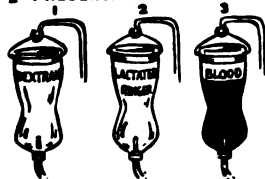
## THIRD PHASE

*Reconstruction  
Rehabilitation*

CHART 10

## TREATMENT OF BURNS IN PRIMARY PHASE (OF FIRST 7-10 DAYS)

### I PRESERVATION OF LIFE



SEDATION

### 1 RESTORATION OF THE CALCULATED EXTRAVASCULAR LOSS, OF COLLOIDS, ELECTROLYTES, AND WATER

*For example give 1 litre (i.e. 1 3/4 pints) of dextroton made up in saline per 10% B.S.B. for first 2 days for all burns of 25%-30% and more, and give 1/2 of first days total in first 8 hrs. of being burnt. Give not more than 6 litres of dextroton plus daily metabolic requirements of 2 litres by mouth. This should contain salt and bicarbonate. For deep burns give 1/2 colloid solution as blood.*

**2 SEDATION** *Give intravenous morphin 1/4-1/2 grs. or ameson grs. 3rd. Restlessness and clouding of consciousness are generally due to anaemia and electrolyte imbalance :- give i.h. colloids and electrolytes rather than more morphia. Give full luminal for later restlessness and hallucinations.*

*Give full systemic rather than local antibiotics. Progress is checked chiefly by clinical signs: RISING PULSE-FALLING PULSE VOLUME-COLD EXTREMITIES-SWEATING VOMITING-CLOUDING OF CONSCIOUSNESS. But try to keep urinary output 30-50 cc per hour*

\* Heroin grs. 1/4 is preferable as it causes less vomiting

CHART 11



# TREATMENT OF BURNS IN PRIMARY PHASE

(Continued)

(B)



**UNIVERSAL DRESSING** *Essential during transport. Can be applied over clothing and without toilet. Later a toilet is preferable; it may be combined with partial exposure*

*Splints for dorsiflexion of wrists and of ankles are essential, i.e. extension of the wrist is the key to the position of function of the hand*

CHART 12

# TREATMENT OF BURNS IN PRIMARY PHASE

(Continued)

(C)

**2 EXPOSURE** *This is not for the collecting zone nor during transport. Cold and shivering may prevent its use in early phases of extensive burns. It is not suitable for most hand burns which need splintage in position of function.*

*Almost all over burns can be adequately treated by exposure.*

**3 PLASTIC AND OIL SILK ENVELOPES** *These have an early role for burnt hands in those who must remain in action.*

**4 LOCAL PRIMARY EXCISION AND REPAIR** *This is practicable only for small deep burns e.g. electric burns and some burns in epileptics.*

**EARLY SURGERY** *may also be necessary*

**1 TRACHEOTOMY** *-when steam has scorched the glottis causing dyspnoea and restlessness.*

**2 DECOMPRESSION OF TIGHT CIRCUMFERENTIAL SLOUGHS**, *acting as tourniquets*

**3 TARSORRHAPHY** *-for retracted lids causing dry cornea.*

**4 EXCISION OF DEAD MUSCLE** *(before it affects kidneys).*

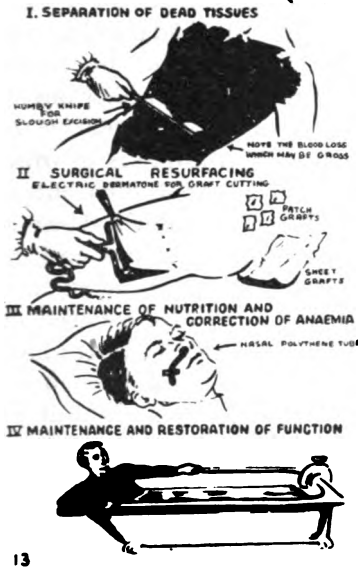
**NOTE ALSO ADVERSE EFFECT IN BURNS OF COINCIDENT  $\gamma$  RADIATION**

CHART 13

## TREATMENT OF BURNS

### II. IN THE HEALING OR SECONDARY PHASE

#### (FROM THE SECOND WEEK)



*Chemical debridement agents are so far inefficient.*

**SURGERY**—by scissors, Hunby Knife or Electric dermatome and when possible under a tourniquet—is the method (but never be used on the face). Sloughs are generally removed in 3rd week, and in stages in very extensive burns between 3rd and 6th weeks.

Resurfacing is by free grafts—continuous "sheet" grafts for small areas, for hands and for faces, and for flexor creases; discontinuous "patch" grafts for extensive burns.

Resurfacing should start in 3rd week and be complete by 6th in most cases. Homografts have a very limited temporary role for the most extensive deep burns between the 3rd and 6th weeks.

Resurfacing by flaps may be necessary when bare bone or tendon is exposed, e.g. in hands.

The diet is high in protein (concentrated milks), high in Vitamin C, high in sulphur. Fat emulsions by nasal polythene tubes may be necessary. Repeated transfusions may be necessary until resurfacing is complete. Appropriate full systemic antibiotics are given until grafting is complete.

Special psychological needs especially those of reassurance and of continuity of nursing and surgical control.

Note that an over sedated patient eats badly.

Movements of unaffected parts are maintained from start.

Movements of affected parts start in 2nd week.

Note the great value of saline baths in the most extensive cases (from about 3rd week) for softening sloughs, and for restoring big joint movements.

CHART 14

mouth. This fluid should contain salt and bicarbonate (1 gm. salt and 1.5 gm. sodium bicarbonate per quart).

I have no experience of the intra-arterial or of the sternal routes in the administration of urgent infusions for burns, but they might be considered for extensively burnt pulseless patients. For other patients seen in advanced shock a polythene tube may be introduced into the femoral vein through the saphenous vein in the groin. It is quite permissible to cut through burnt skin. Urinary output, which should be over 30 ml. per hour, is one guide to the rate of fluid requirement, but clinical improvement or deterioration is probably more reliable, that is, watch the pulse rate and volume, the temperature of exposed parts, and for the relief of thirst, and for vomiting, and for clouding of consciousness. Systemic penicillin, 1,000,000 units a day of procaine or of some persistent compound, is given. (Topical penicillin is less reliable.) Later other antibiotics may be indicated.

#### Local Treatment

Charts 12 and 13 indicate the local treatment. Choice of definitive primary treatment lies between an absorptive dressing, exposure, use of an oilsilk envelope, and primary excision and repair.

**Absorptive Dressings.**—If a burn is covered by a dressing it must first be given

a thorough toilet, and this toilet of the affected parts plus adjacent skin must be done by an efficient detergent. It can be carried out under intravenous omnopon. A particularly thorough toilet is, of course, necessary when the burnt area has been soiled. It is best to evacuate blisters, but no attempt is made to remove their epithelial roofs. The Universal Dressing in one of two standard sizes can be very quickly and readily applied. It is maintained in position by cotton bandage (preferably of the "Kling" type with a two-way stretch). Either one or two large dressings are sufficient to cover a complete leg or arm ; and one on the front and one on the back covers the trunk. The dressing comprises an inner layer of fine mesh gauze, then a layer of absorptive cotton-wool, then one of non-absorptive cellulose, and an outer layer of sisal. At the Burns Unit at Guy's Hospital, where we have had them on trial for a year, we have found the Universal Dressing a satisfactory answer to the problem of providing an efficient quick dressing with good absorptive properties. They have to be renewed on being soaked through ; but this is seldom necessary before two to three days. The inner layer could with advantage be of some softer, less adhesive material with a lower coefficient of friction (like the Winchester rayon introduced by Neal Owens). An absolute essential in its use for the hands is that the hands be supported in the position of function. The key to the position of function of the hand is extension of the wrist. This is probably best obtained by a cock-up splint applied outside the Universal Dressing. Feet also must be kept dorsiflexed. These Universal Burns Dressings may be used in conjunction with exposure for extensive circumferential trunk burns. The patient lies on one large square while exposing the opposite side, and later lies on the previously exposed side while the other side is exposed and dried.

*Exposure.*—Exposure is quite unsuitable during the period of evacuation, but it is an acceptable method for almost all other burns in the holding zones, except those of the hand. It is important to maintain immobilization of all affected parts in the position of function, and to see that burnt areas are not rubbed by sheets and bedding. In all except tropical zones, shivering in the early days can be a most troublesome feature in patients who have extensive areas exposed. It may lead to the temporary adoption of covering by the Universal Dressing ; but exposure may be reverted to later. Towards the end of the third week the separation of the eschar may be accelerated by the use of paraffin or triptar packs. Primary burns treated by exposure are more difficult and are slower to distinguish from full thickness burns than they are when treated by toilet and dressing. It is often the end of the third or well into the fourth week before the scab separates or the depth of the scab can be diagnosed with confidence. Freedom from dressings is a great advantage to burns treated in the tropics, but special care must be taken there to keep the wards free of flies to avoid maggot infestations.

*Envelopes.*—The only role for oil or nylon envelopes for the hands, in my view, is as a personal dressing carried by a soldier to be applied in the field immediately after flash burns of the hands when he must remain in action. It should be remembered that most flash burns of the hands will not affect palms or volar surfaces of the fingers. Some use of the hands after burning should be entirely

practicable, but protection of the blistered dorsum is necessary during this period of use. An oilskin Bunyan bag would provide this. It would be abandoned on reaching the holding zones, to be replaced, after a toilet, by Universal Dressing and cock-up splints.

*Primary Excision and Repair.*—The ideal in treatment of full thickness skin loss burns is to excise the affected part, do a repair at the same operation, and so terminate the disease. This is only practicable in small manifestly deep burns, such as electric burns to the palms of the hands of children. The difficulties in more extensive burns lie in lack of certainty of distinction between what is full thickness loss and what is a dermal burn, and the fact that excision of even as much as 10 per cent. of the body surface area with the intense hyperæmia present may cause such serious blood loss as to overtax an already gravely ill patient. Nevertheless this is the direction in which modern treatment of extensive deep burns is moving. Hypotensive anæsthesia helps in this by limiting blood loss in early slough excision. The use of skin banks with homogeneous grafts from multiple donors, possibly selected because of their low antigenicity, may provide a future means of preventing some of the later deaths which occur in extensive deep burns after they have been saved by full orthodox anti-shock treatment in the first week.

#### SECONDARY OR HEALING PHASE

I would again emphasize the importance of a programme for removal of the dead tissues and for rapid surgical resurfacing. For most patients it should be possible to clear the sloughs completely in the second to fourth week and to have completed the grafting programme by the fourth or sixth week. The most extensive cases, and those at the extremes of life, must be handled at a slower pace ; but even for these cases it is most important that time should not be lost through lack of definite schedule and plan. There is an optimum time for grafting, which is at the early excision of sloughs or within a few days of it. After this the proportion of graft loss tends to rise. On the technical side, I would mention the value of working under tourniquet protection when possible, and of diathermy for hæmostasis, at the time of slough removal. The type of cover that is ideal is that by sheets of continuous split skin grafts, but these need experience both in cutting and in fixation. I would re-emphasize the general value of the discontinuous patch graft method for extensive burns, except on such areas as the eyelids, the hands, and on the flexor crease. The two most valuable grafting instruments at this healing stage, which may be also used in the removal of sloughs with great economy in blood and time, are the Humby knife and the electric dermatome.

I would also confirm the value of saline baths in the later stages of the treatment of extensive burns. Not only do they help the general morale of the patient, but they assist in the return of big joint movements.

The programme along which severe burn casualties are nursed back to health is a long and complicated one. During this the majority of patients will suffer an enormous amount of pain, and most will have complications and setbacks of one sort or another. Many people will share in their treatment—surgeons,

anæsthetists, other doctors, nurses, physiotherapists, and occupational therapists. It is highly desirable that the patients themselves should know, especially in the earliest stages, that clinical responsibility for their well-being rests with one surgeon. They should have no doubt about the broad outlines of the programme along which they are to be nursed back to health ; nor should they have any doubt that this programme is known and supported by all who share in their care. As a group, extensively burnt patients are in their attitude to others extremely dependent for many weeks and months. They almost all, from the very earliest stages, entertain grave fears about the future, with special reference to permanent and gross disfigurement which will prevent their being able to lead normal lives and to maintain themselves in economic competition in the future. Firm reassurance on this point can with great advantage be given to them repeatedly by all who have the responsibility for their treatment.

#### RESUME

Arrangements for burns in future military operations when nuclear weapons are used can be based on the assumption that one of the commonest types of battle casualty will be a white light-infra-red radiation burn. Estimation of numbers is still largely speculative, but a total of well into four figures per division engaged at the time of major explosions would seem reasonably modest. The majority of these burns in survivors will be superficial flash burns of exposed parts, that is of hand and face, and will not need intravenous infusion.

An envelope is an acceptable method of first-aid for the hands, plus possibly the application of an analgesic detergent cream. In the holding zones these hand burns should be given a toilet and covered by the Universal Dressing, being maintained in position of function by a supporting cock-up splint. The facial burns may be exposed throughout ; but some will be more comfortable covered with tulle gras. Most of the battle casualty burns, if not infected, will be healed without disability in two to four weeks.

Extensive secondary (conduction) burns involving 10-90 per cent. of the body surface will be numerous enough to make big demands on medical time and on supplies. Burns of 50-60 per cent. of the body surface can be saved at the rate of about 1 in 2 ; those of 30 per cent. body surface at the rate of about 9 in 10. But a 90 per cent. body surface burn is given no more intravenous fluid than a 60 per cent. body surface burn. It should not be necessary therefore to implement a policy of exclusion from treatment of the most severe cases.

Trunk and limb burns must be covered in the collecting zones. The Universal Dressing makes it possible to do this rapidly and efficiently. A later toilet with a detergent and under an opiate will be desirable for most when the holding zone is reached. A high dosage with a persistent penicillin product given systematically should be routine, except for those patients known to be sensitive to the antibiotic. A.T.S. should also be given. Intravenous fluid is necessary for those burnt 25-30 per cent. or more. For the 25-30 per cent. groups it should be given within eight hours. The 50-60 per cent. body surface burnt groups need it more quickly—within two hours—for optimum survival. A fair proportion of this

intravenous therapy must therefore be given or started in the collecting zones. The intravenous fluid of choice today is 5 per cent. high molecular dextran in normal saline or balanced salt solution. The 30 per cent. body surface burn group get 6 pints in the first two days (plus fluid by mouth) ; the most dextran given to any of the more extensively burnt patients (*i.e.*, 60-90 per cent. body surface burn) is 12 pints in two days. For deep burns a third to a half of this early intravenous fluid should be blood, when it is available.

I would estimate (but guess would be a better word) that only about 10 per cent. of the total surviving burns casualties after a nuclear explosion would need intravenous infusion—a similar figure to that for the missile wound casualties of World War II. A pint of dextran, in a nylon or polythene bag, occupies about the same space for package and transport as a Universal Dressing does. Three Universal Dressings may be the average requirement per body-limb burn in the collecting zone ; that is, one lorry will hold enough for 1,000 casualties. The transport needs of the dextran necessary for first-aid collecting zone treatment may be found to be much the same. For the first two days in the holding zone the requirements might be about double this, again per 1,000 casualties. That is, clinical planning for this type of warfare is a practical problem ; but considerable allowances will also have to be made for civilian needs, and for the effects of repeated nuclear explosions occurring at a time when holding zones and all base units are already full and overtaxed with the heavy and protracted demands on the medical services and supplies which the deep burns of earlier explosions would be making.

I would like to express my special thanks to Lieut.-Colonel Ed. Pulask, M.C., U.S. Army, Walter Reed Hospital, Washington ; to Professor Truman Blocker, Jr., of Galveston, Texas ; and to the late Dr. Harvey Allen, of Chicago, for the extremely kind way in which they have so often let me consult them on problems about burns. In this country I am especially grateful for similar courtesy and help from Mr. Douglas Jackson, Surgeon Captain Beach, R.N., Dr. J. Bull, Mr. A. B. Wallace, and Dr. W. Butterfield.

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# EPIDEMIC RESPIRATORY TRACT INFECTION IN A PREDOMINANTLY YOUNG MILITARY COMMUNITY IN SOUTHERN ENGLAND WITH PARTICULAR REFERENCE TO THE INCIDENCE AND NATURE OF THE PULMON- ARY COMPLICATIONS

BRIEF REPORT ON 500 CONSECUTIVE CASES

BY

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EVERY year hundreds of individuals are diagnosed as having "the flu" when in fact many of them have the common cold, febrile catarrh, bacterial sore throat, or less common conditions such as infection with the Psittacosis-L.G.V. group of viruses, "Q" fever or other influenza-like illnesses; for example, non-paralytic poliomyelitis or even leptospirosis or paratyphoid fever.

Not only that, but when opacities are demonstrated on chest radiographs in such cases they are frequently promptly designated "aspiration pneumonia" or "primary atypical pneumonia." The former label gives quite the wrong impression regarding the mode of production of such pulmonary opacities, while the latter is a diagnostic rubbish heap reserved for inadequately investigated cases of pyrexia with abnormal signs, clinical and/or radiological, in the chest.

In bacterial pneumonias there is normally an increase in volume of the area(s) of the lung(s) affected. Virus pneumonias, on the other hand, are characterized by a diminution of the area(s) of the lung(s) affected. Initially in such cases there is atelectasis due to local bronchial conditions characterized by a most intensely adhesive, elastic and tenacious mucous secretion, the best descriptive term being an adhesive bronchial pneumonia.

In order to learn more about epidemic respiratory infection, essentially in young soldiers, we determined to investigate 500 consecutive cases admitted to the Army Chest Centre between 15th January, 1953, and 5th May, 1953, as upper respiratory tract infection (U.R.T.I.). Every case had a radiograph of the chest on admission to hospital. The following serological reactions were carried out in all but one of the patients who had abnormal radiological findings in the chest, and on random cases among the remainder: Influenza virus A and B; Streptococcus M.G. agglutinins; Psittacosis-L.G.V. group of viruses; "Q" fever.

The cases were selected in that it was arranged that this hospital would take the *mildest* of the U.R.T.I. cases as an overflow from hospitals in the district which would normally deal with such cases.

Of the 500 consecutive cases sent for admission as U.R.T.I. there were 13 cases diagnosed as follows :

Infectious mononucleosis ... ..	6
Rheumatic fever ... ..	1
Rubella ... ..	1
Tuberculous pleural effusion (A and A.F.B. isolated on culture) ... ..	1
Transverse myelitis ... ..	1
Herpetic stomatitis ... ..	1
Malaria (M.T.) ... ..	1
Scarlet fever ... ..	1

The remaining 487 cases were then divided into the following groups, which are as defined by Stuart-Harris (1953), but points of difference will be stated later.

Group 1 : Common cold ... ..	8
Group 2 : Bacterial sore throat ... ..	112
Group 3 : Febrile catarrh with exudate ... ..	47
Group 4 : An influenza-like illness with	
(a) No evidence of catarrh ... ..	51
(b) Minimal catarrh ... ..	67
(c) Marked catarrh ... ..	202

By "bacterial sore throat" we mean all cases clinically indistinguishable from streptococcal sore throat but where  $\beta$ -hæmolytic streptococci may or may not be isolated and where the response to penicillin therapy is the same.

We use the term "febrile catarrh with exudate" because Stuart-Harris states that such cases are never influenza.

In our experience of influenza as it has been presenting itself since the 1918 pandemic, we feel that clinically we cannot distinguish influenza from febrile catarrh without exudate or even from the Psittacosis-L.G.V. group of viruses or "Q" fever. That is our reason for Group 4.

In any case it is now accepted in authoritative circles that virus diseases cannot be diagnosed with any degree of accuracy without serological testing.

#### DISTRIBUTION OF CASES BY AGE AND BY LENGTH OF SERVICE

	Numbers of patients	Under 18 years	18-20 years	21-25 years	Over 25 years	Oldest	Youngest	Average
Group 1	8	1	4	3	—	—	—	19.9 years
Group 2	112	1	84	18	9	40 years	17 years	19 years
Group 3	47	1	37	8	1	38 years	17 years	19.1 years
Group 4(a)	51	6	35	9	1	27 years	15 (2) years	19.2 years
Group 4(b)	67	4	45	15	3	37 years	16 years	20 years
Group 4(c)	202	5	158	32	7	48 years	15 years	19.5 years



## SERVICE

	Numbers of patients	Less than two months	Two months -six months	Seven months -two years	More than two years
Group 1 ... ..	8	2	1	5	—
Group 2 ... ..	112	18	66	20	8
Group 3 ... ..	47	16	20	8	3
Group 4(a) ... ..	51	5	27	17	2
Group 4(b) ... ..	67	12	39	15	1
Group 4(c) ... ..	202	68	63	58	(Reservist) 13

*N.B.*—Throughout all groups it will be seen that the average age was 19-20 years, and that only a small minority were over 25 years. The vast majority had less than six months' service and so, being unaccustomed to barrack-room life, were more susceptible to U.R.T.I. than the regular soldier of several years' service.

## HÆMATOLOGY

## GROUP 1

The total and differential white blood counts were all within normal limits, including the case from which a coagulase positive *Staphylococcus aureus* was cultured from a throat swab.

## GROUP 2

In cases with  $\beta$ -hæmolytic streptococci in the throat, 22 out of 27 had a total white blood cell count above 10,000/c.mm. The range was 7,000/c.mm. to 21,000/c.mm. The mean was  $13,000 \pm 2,500$ /c.mm. In cases with no  $\beta$ -hæmolytic streptococci the total white blood cell count was raised above 10,000/c.mm. in 29 out of 85 cases. Counts ranged between 5,000/c.mm. and 20,000/c.mm., but the mean count was  $9,600 \pm 3,000$ /c.mm. Therefore in this group the only differentiation is the result of the throat swab. Total and differential white blood cell counts were carried out on all cases but one.

## GROUP 3

Total and differential white blood cell counts were performed on admission on 45 of the 47 cases.

The average total white cell count for this group was  $9,000 \pm 3,400$ /c.mm., the range extending between counts of 5,000/c.mm. and 19,000/c.mm.

Fourteen cases had counts above 10,000/c.mm. ranging from 11,000/c.mm. to 19,000/c.mm. The four patients with abnormal radiological findings in the chest had counts of 15,000/c.mm., 7,000/c.mm., 13,000/c.mm. and 13,000/c.mm. respectively. It will be seen that from the hæmatological point of view also there is little to separate this group from cases in Group 2 from whom  $\beta$ -hæmolytic streptococci were not isolated.

## GROUP 4 (a)

In this group 14 patients had total white cell counts above 10,000/c.mm. The range was from 11,000/c.mm. to 17,000/c.mm. In these, polymorph figures varied between 66 per cent. and 87 per cent.

The mean total white blood cell count of the whole group was  $8,600 \pm 3,000/\text{c.mm.}$  with an average polymorph percentage of 64 per cent. (range 44-88 per cent.).

White cell counts were carried out in 48 cases. The three cases with hæmolytic streptococci in the throat each had a total white cell count of  $14,000/\text{c.mm.}$

The two cases of influenza A, one with and one without radiological changes, and the two cases of influenza B all had normal total and differential white cell counts.

#### GROUP 4 (b)

All but 11 of 60 cases examined had total counts of less than  $10,000/\text{c.mm.}$

In this group of cases, excluding three from whose throats a pure growth of  $\beta$ -hæmolytic streptococci was obtained, a raised white blood cell count was a pointer to the presence of radiological changes in the chest. A normal white cell count was, however, compatible with such changes in a few cases suffering from influenza A and in four with a negative serology.

#### GROUP 4 (c)

All but 14 of the 202 cases were examined. Only 47 cases had counts above the upper limit of normal.

Of the cases with raised white cell counts :

4 had a profuse growth of  $\beta$ -hæmolytic streptococci ;

16 had abnormal chest radiographs ;

7 had abnormal physical signs in the chest with normal radiographs.

The remainder had no obvious cause for their raised counts.

### *Hæmatology of Cases with Pulmonary Opacities*

Of the 65 cases in this group on whom serological data are available, all but four had total and differential white cell counts done on admission to hospital.

From the hæmatological point of view it will be easier to consider the cases grouped according to the serological findings.

#### 1. *Influenza A.*

Fourteen cases with radiographic changes were found to be suffering from influenza A. If one takes the normal white cell count as being  $5-10,000/\text{c.mm.}$  all but two of these cases had normal counts. The two in which the count was raised, to  $12,700$  and  $12,800/\text{c.mm.}$  respectively, both fell in the sub-division of those with considerable radiographic changes ; in fact both had atelectatic consolidation of a lower lobe. In the remainder the counts varied between  $5,000$  and  $10,000/\text{c.mm.}$  The average count for the 14 cases is  $8,000/\text{c.mm.}$

These figures may be compared with those in the group of cases, 11 in number, who had serological evidence of influenza A infection without radiographic changes. The counts for the latter varied between  $5,000$  and  $9,000/\text{c.mm.}$  with a mean of  $6,400$ .

Thus from the 25 cases in all, suffering from influenza A, the generalization

may be drawn that cases of influenza A have a normal white cell count even if radiographic changes complicate the picture, unless those changes are very considerable in extent, *e.g.*, atelectatic consolidation of a lobe.

## *2. Influenza B.*

The results of the white cell counts of patients suffering from influenza B provide an interesting comparison with those patients infected with the A virus. Of the 12 patients in the B virus group who had radiographic changes in the lungs, blood counts were performed on only ten. The two in whom this was not done fall into the "slight" division of radiographic appearances. Among these ten patients all but two had total white cell counts of more than 10,000/c.mm. The exceptions were counts of 8,600 and 6,200 respectively. This is in contrast with the patients in the A virus group who had radiographic changes. The two patients with normal white cell counts fell in the "medium" and "considerable" radiographic groups respectively. Among the others the counts ranged between 10,000 and 27,000/c.mm., the average for the group being 13,800/c.mm. There is no correlation between the height of the white cell count and the degree of pulmonary involvement. The level of the white cell count in the virus B group with radiographic changes may be compared with that in the few patients in whom serological evidence of infection with virus B was found but had no changes in the lungs on radiography. In the latter the counts ranged from 5,000 to 8,000/c.mm. with a mean of 6,500/c.mm.

From this section and the last the following trends can be discussed, though it is admitted that the numbers concerned are small. In cases of influenza A and influenza B, uncomplicated by pulmonary radiographic changes, the white blood cell count is within normal limits. In the case of virus A infection, radiographic changes in the lungs are associated with a raised count only if these changes are extensive in degree. In the case of virus B, radiographic changes in the lungs are associated with a raised white cell count in the majority of cases, and this occurs independently of the extent of the radiographic shadows.

## *3. Negative Serology*

This group is more difficult to analyse from the hæmatological point of view since although they are not suffering from influenza there is no reason to suggest that they represent a homogenous ætiological division. White cell counts were carried out on admission in all but two of the 34 cases in this group. Counts above 10,000/c.mm. were found in 15 cases. Five of these were in the division with "slight" radiographic changes, six with "medium" and four with "considerable" shadowing. Thus, as the amount of shadowing increases, more patients tend to have raised counts in the various groups, though patients with normal white cell counts are found in all three sub-divisions. In the "slight" radiographic changes group the mean count is 10,000/c.mm., the "medium" 11,400, and in the "considerable" 15,300, though these figures are without statistical significance.

In the latter group one patient had a count of 43,000/c.mm. associated with very extensive atelectatic consolidation.

The most that can be said for this group is that the white cell count varied from the normal to the very high. There is no close correlation between the extent of the radiographic appearances and the level of the count except that there is a tendency for the group with more extensive radiographic changes to contain a high proportion of individuals with abnormally high white cell counts, though extensive changes were found in association with counts of 5,800, 6,800 and 8,000/c.mm.

#### 4. "Q" Fever

Only one case falls in this group. The radiographic changes were "medium" in extent and the white cell count 5,000/c.mm. This is the usual finding in the early stages of this disease.

#### 5. Psittacosis

This group includes four cases among whom there is some correlation between the extent of the changes in the lungs and the level of the white cell count. Thus in three patients with "moderate" radiographic changes the counts were 6,200, 7,600 and 9,000/c.mm. respectively, whereas the patient with "considerable" pulmonary involvement had a white cell count of 24,000/c.mm.

### VIRUS SEROLOGY

In the 487 cases of U.R.T.I. described in this paper, virus serology was carried out in 108 cases (22.1 per cent.). However, 65 cases showing radiological changes were selected for serology and therefore could not be called random cases.

The following shows in diagrammatic form the results obtained :

Influenza A	Influenza B	"Q" Fever	Psittacosis L.G.V. Group	Negative Serology	Total
25	17	1	4	61	108

	Total cases	Serology tested	Influenza A	Influenza B	"Q" Fever	Psittacosis— L.G.V. group of viruses	Streptococcus M.G. agglutinins	Negative serology
Group 1 ...	8	—	—	—	—	—	—	—
Group 2 ...	112	7 (1R)	—	—	—	—	—	7 (1R)
Group 3 ...	47	10 (4R)	—	—	—	—	—	10 (4R)
Group 4(a) ...	51	6 (1R)	2 (1R)	2	—	—	—	2
Group 4(b) ...	67	24 (16R)	7 (3R)	3 (3R)	—	2 (2R)	—	12 (8R)
Group 4(c) ...	202	61 (43R)	16 (10R)	12 (9R)	1 (1R)	2(2R)	—	30 (21R)
Total ...	487	108 (65R + 1R A.W.O.L.)	25 (14R)	17 (12R)	1 (1R)	4 (4R)	—	61 (34R)

R = With radiological changes.

## BACTERIOLOGY

## GROUP 1

Throat swabs were taken in three cases. In one there was a growth of *Staph. aureus* and in two a moderate growth of pneumococci.

## GROUP 2

Throat swabs were taken on admission in 98 cases of this group (88 per cent.).  $\beta$ -hæmolytic streptococci were isolated in pure culture in 27 cases. In a further six cases  $\beta$ -hæmolytic streptococci in association with other organisms were isolated. *Streptococcus viridans* was isolated in pure culture in three cases. *Hæmophilus influenzae* was isolated in two cases; in the remainder either pneumococci or non-hæmolytic streptococci were isolated either in pure culture or associated with *Neisseria catarrhalis*. The pneumococci were not identified serologically.

The patient with radiological changes in the lung had a growth of non-hæmolytic streptococci and *N. catarrhalis* in a throat swab.

Of the six patients with abnormal physical signs in the chest, four had a pure growth of  $\beta$ -hæmolytic streptococci in throat swabs and two had pure growths of non-hæmolytic streptococci.

The proportion of patients in this group from whom  $\beta$ -hæmolytic streptococci were isolated in pure culture is exactly the same as that revealed by the American Commission on Respiratory Diseases (1944).

In the 72 per cent. of cases where  $\beta$ -hæmolytic streptococci were not isolated, the character and appearance of the tonsillar or faucial exudate and œdema, combined with the almost invariable tonsillar adenitis, favoured in our view the presence of a bacterial infection rather than febrile catarrh.

## GROUP 3

In no case were  $\beta$ -hæmolytic streptococci isolated. Throat swabs were taken from all but eight patients in this group.

In three cases there was an almost pure growth of *Strep. viridans*. In the remainder the plates produced the normal throat flora or, occasionally, pneumococci or non-hæmolytic streptococci were found in pure culture. It will thus be seen that from the bacteriological point of view there is little to distinguish this group from the cases in Group 2 from which  $\beta$ -hæmolytic streptococci were not isolated.

Of the four patients in this group with abnormal radiological findings in the lungs, the throat swabs from two gave a pure growth of non-hæmolytic streptococci, from one a pure growth of pneumococci and from the other a mixture of mouth commensals.

Throat swabs were taken from four of the five patients with abnormal physical signs in the chest but without abnormal radiological findings. One had a pure growth of *Strep. viridans*, two had pure growths of non-hæmolytic streptococci and one a pure growth of untyped pneumococci.

## GROUP 4 (a)

Throat swabs were taken on admission from 30 cases in this group. From three swabs  $\beta$ -hæmolytic streptococci were isolated in pure culture, while from three others occasional colonies were found associated with other organisms. In one case among the latter the few colonies of hæmolytic streptococci were associated with a profuse growth of *H. influenzae*. From two patients, one with influenza B, a moderate pure growth of *Strep. viridans* was obtained, and from the case of influenza A without radiographic changes a heavy growth of *Staph. aureus* associated with a pneumococcus.

The case of influenza A with an abnormal chest radiograph had a profuse growth of pneumococci in the throat swab. This organism was not serologically typed. The other case of influenza B also had a pneumococcus from a throat swab. The culture from the remaining cases showed nothing distinctive and consisted largely of normal throat commensals.

## GROUP 4 (b)

Bacteriological examination of throat swabs and/or sputum was carried out in only 36 cases in this group. A profuse growth of  $\beta$ -hæmolytic streptococci was found in throat swabs from three cases. None of the three had physical signs in the chest or radiographic abnormalities. From the remainder, non-hæmolytic streptococci or pneumococci were found usually in association with the normal throat commensals. Neither *H. influenzae* nor *Staph. aureus* was found in this group. There is nothing from the bacteriological point of view to explain why some cases of influenza had radiographic changes and some did not, nor to explain why some cases with radiographic changes had raised white cell counts while others did not. No characteristic difference is noted between influenza A, influenza B and these cases with a negative serology.

## GROUP 4 (c)

Throat swabs and/or sputum were examined bacteriologically in three-quarters of the cases in this group. A profuse growth of  $\beta$ -hæmolytic streptococci was found in the swabs from 12 cases.

The cases of psittacosis and "Q" fever had no organisms in their throat other than commensals. *Staph. aureus* was not obtained from the sputum of any case with radiological opacities in the lungs.

There was no characteristic difference in the bacterial flora of those cases showing evidence of infection with influenza A or B, with or without radiographic shadows in the lungs. In some cases, including some with and some without radiographic changes, a profuse growth of pneumococci was obtained from throat swabs or sputum, but unfortunately serological typing was not carried out. In one case with a negative serology and a very extensive shadow, having a white cell count of 43,000/c.mm., the highest in the series, a pure culture of  $\beta$ -hæmolytic streptococci was obtained from the throat swab, and of pneumococci from the sputum. Pure growths of pneumococci were, however, obtained from the sputum of only a small minority of all the cases with radiographic changes in the lungs.

## CASES WITH RADIOLOGICAL OPACITIES

The radiological appearances were those of minimal (*i.e.*, mottling), sub-segmental, segmental or lobar atelectatic consolidation.

*Extent and Incidence of Radiological Changes in the Various Groups*

Group 2 : One case of small extent.

Group 3 : 4 cases :  
           2 were of small extent,  
           1 was of medium extent,  
           1 was of considerable extent.

Group 4 (a) : 1 case of small extent.

Group 4 (b) : 16 cases :  
           6 of small extent,  
           5 of medium extent,  
           5 of considerable extent.

Group 4 (c) : 44 cases :  
           17 of small extent,  
           17 of medium extent,  
           10 of considerable extent.

*N.B.*—We believe that all groups in our classification are not difficult to recognize. Therefore the following figures are, in our opinion, of great significance :

In Group 4(b) and (c), 60 out of 269 cases had radiological abnormalities, *i.e.*, *more than 1 in 5*.

In Group 4(a), (b) and (c), 61 out of 320 had radiological abnormalities *i.e.*, in 19 per cent. of cases or *almost 1 in 5*.

In combined Groups 3 and 4 (a), (b) (c), 65 out of 363 had radiological changes, *i.e.*, 17.4 *per cent.* of all such cases, while in Group 3 plus Group 4(b) and (c), 64 out of 316 had radiological changes, *i.e.*, 20.2 *per cent.* or 1 in 5.

*Radiological Involvement in the 66 Cases*

Extent :								
Small	...	...	...	...	...	...	...	27
Medium	...	...	...	...	...	...	...	23
Considerable	...	...	...	...	...	...	...	16

*Distribution of Radiological Changes*

In 10 cases the changes were bilateral.

In 43 cases only one segment appeared to be involved, whereas in the remaining 23 cases more than one segment was involved.

Complete lobar involvement :

In six cases the whole of a lobe was involved—

Right lower lobe	...	...	...	...	...	...	2
Left lower lobe	...	...	...	...	...	...	3
Right middle lobe	...	...	...	...	...	...	1

Partial lobar involvement :

Right upper lobe	...	...	...	...	...	...	4
Left upper lobe (excluding lingula)	...	...	...	...	...	...	4
Right middle lobe	...	...	...	...	...	...	17
Lingula	...	...	...	...	...	...	10
Right lower lobe	...	...	...	...	...	...	21
Left lower lobe	...	...	...	...	...	...	23

*Distribution of Segmental Involvement*

Right lower lobe :

Posterior segment	...	...	...	...	...	...	13
Anterior segment	...	...	...	...	...	...	10
Lateral segment	...	...	...	...	...	...	1
Apex of right lower lobe	...	...	...	...	...	...	1

Right middle lobe (segment is not specified) ... .. 17

Right upper lobe :

Anterior segment	...	...	...	...	...	...	4
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Left upper lobe :

Anterior segment	...	...	...	...	...	...	3
Lingula	...	...	...	...	...	...	10

Left lower lobe :

Posterior segment	...	...	...	...	...	...	14
Anterior segment	...	...	...	...	...	...	8
Lateral segment	...	...	...	...	...	...	4
Apical segment	...	...	...	...	...	...	1

CASES WITH RADIOLOGICAL CHANGES

*Duration of Radiological Changes*

Less than 10 days	...	...	...	...	...	14 cases
10-14 days	...	...	...	...	...	14 cases
14-21 days	...	...	...	...	...	13 cases
21-28 days	...	...	...	...	...	8 cases
1-2 months	...	...	...	...	...	12 cases
Over 2 months	...	...	...	...	...	5 cases

One case cleared after three months.

Two cases cleared in 60 and 69 days respectively.

One case had persistent lingular atelectasis with bronchiectasis.

One case was thought to be an old middle lobe syndrome of tuberculous origin.



## COMPLICATIONS

GROUP 1. Nil.

GROUP 2

*Extrapulmonary.*

- (1) One case had maxillary sinusitis, confirmed radiologically, which settled with treatment in 15 days.
- (2) One patient had peritonsillar abscess.

*Pulmonary.*

- (1) *Radiological abnormality.*—One patient had no abnormal physical signs in the chest but radiographs revealed bilateral basal opacities which cleared in nine days.
- (2) *Abnormal physical signs.*—Three patients, all with a productive cough, had generalized medium rhonchi and crepitations throughout both lung fields with normal radiographs. Two of these patients had a previous history of recurrent attacks of bronchitis. In two cases, the chest was clear within seven days, but in the third case abnormal physical signs persisted up to the 24th day.
- (3) *Localized abnormal physical signs.*—Two patients had fine crepitations confined to a small area of one lung which persisted after coughing. In both cases the chest was clear within 48 hours. Admission radiographs appeared normal.

GROUP 3

There were no definite extrapulmonary complications in this group. Several patients had a history suggestive of sinusitis with nasal catarrh and severe frontal headache. These cases cleared rapidly under treatment and no cases were confirmed radiologically.

*Intrapulmonary.*

- (1) Three patients who had no abnormal physical signs in the chest were found to have pulmonary opacities. These cleared in 21, 16 and 18 days respectively.
- (2) *Physical signs and radiological appearances of atelectasis of the right lower lobe.*—One patient had atelectasis of the right lower lobe which cleared in 24 days radiologically, but after 19 days no abnormal physical signs were detected.

GROUP 4(a)

*Abnormal Chest Radiograph.*—One patient was found to have a small opacity in the upper lobe of the right lung, which cleared within seven days.

*Others.*—One patient had diarrhoea for three days in addition to general symptoms. Serology showed this case to be one of influenza B.

One patient had cervical adenitis for four days after admission, for which no cause was found.

## GROUP 4(b)

Under this heading are included various extrapulmonary complications and the presence of abnormal physical signs in the chest or abnormal chest radiographs.

Since by definition all of this group have either abnormal physical signs or unproductive cough, the incidence of complications is high (45 per cent.).

*Extrapulmonary.*

- (1) *Otitis Media*.—Two patients were found to have an otitis media, one with pulmonary complications in addition. Both responded rapidly to chemotherapy.
- (2) *Tonsillitis*.—One patient developed tonsillitis eight days after admission.
- (3) *Sinusitis*.—One patient developed maxillary sinusitis confirmed radiologically.

*Pulmonary.*

These fell into three groups which will be considered under the headings of :  
Physical Signs in Chest and Radiology :

10 cases with abnormal physical signs only.

14 cases with physical signs and abnormal chest radiographs.

2 cases with abnormal radiographs and no abnormal physical signs.

Incidence of radiographic abnormality 24 per cent. (61 per cent. of these with abnormal physical signs).

Total complicated cases	...	...	...	...	30 (45%)
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Total uncomplicated cases	...	...	...	...	37 (55%)
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## GROUP 4(c)

*Extrapulmonary Complications*

- (1) *Laryngitis*.—Twelve patients had some degree of laryngitis on admission. Three were complaining of hoarseness which cleared within two days of admission. In three cases, in addition to evidence of laryngitis, there were abnormal physical signs in the chest, consisting of scattered rhonchi throughout both lung fields (these have been included among those with abnormal physical signs). In the remaining six cases there was marked laryngitis with considerable loss of voice as the main feature of the illness (included in the complicated group below).
- (2) *Sinusitis*.—A considerable number of patients had symptoms and signs suggestive of sinusitis, with persistent catarrh, frontal headaches and tenderness over the sinuses. In only two cases was this persistent and in both maxillary sinusitis was confirmed radiologically. (One of these had an abnormal chest radiograph ; the other is included in the complicated group below).

- (3) *Tonsillitis*.—One patient was admitted with tonsillitis, in addition to an abnormal chest radiograph and positive serology for influenza A. Another developed tonsillitis on the eighth day of illness.
- (4) *Pyelitis*.—One patient had pyelitis which responded to chemotherapy.
- (5) *Gastro-enteritis*.—One patient, in addition to an abnormal chest radiograph, had symptoms suggestive of mild gastro-enteritis.

#### *Pulmonary Complications*

Ninety-three patients had either abnormal physical signs or abnormal chest radiographs, or both. These are discussed in detail below under "Physical Signs" and "Radiology."

Abnormal physical signs with no radiographic changes	...	...	...	...	...	...	49
Abnormal chest radiograph with no abnormal physical signs	...	...	...	...	...	...	9
Abnormal chest radiograph with abnormal physical signs	...	...	...	...	...	...	35
Total with abnormal physical signs	...	...	...	...	...	...	84 (42%)
Total with abnormal chest radiograph	...	...	...	...	...	...	44 (22%)

#### *Relation between Symptoms and Complications*

1. *Productive Cough* (normally scantily productive)—

	With productive cough	Without productive cough
Number of cases	125	77
Number with abnormal physical signs	55	29
Abnormal radiograph	32	12

It will be seen that the incidence of pulmonary complications is much higher in those with productive cough. According to Stuart-Harris not more than one-third of uncomplicated cases (of influenza) have sputum.

2. *Pleurisy*.—Of the eight patients who had a definite pleuritic pain, seven had abnormal chest radiographs, and the remaining one had a pleural friction rub, but a normal radiograph.
3. *Dyspnoea*.—Only two patients complained of definite breathlessness at rest. Both had abnormal radiographs.

#### *Symptomatology of Significance in Cases with Radiological Changes*

Pleuritic pain was present in 21 (31.8 per cent.) of all such cases.

Productive cough was present in 32 (72.7 per cent.) of 44 such cases in Group 4(c).

The remaining 12 cases in this group had marked nasal catarrh. The characteristics of the sputum were striking, particularly its *adhesiveness*, *tenacity*

and *elasticity*. In most cases the cough was harsh, irritating and scantily productive of mucoid sputum which never became purulent to the naked eye but always remained predominantly mucoid.

#### *Cases with Radiological Abnormalities*

Forty-six out of the 66 cases had abnormal physical signs as follows :

Generalized medium crepitations and rhonchi	...	...	...	...	4
Generalized rhonchi only	...	...	...	...	3
Bilateral basal crepitations	...	...	...	...	10
Localized fine crepitations	...	...	...	...	8
Signs of consolidation or atelectasis	...	...	...	...	19
Signs of pleural effusion developing after seven days	...	...	...	...	1
Pleural rub only	...	...	...	...	1

#### *Cases with Abnormal Signs in Chest but with normal Chest Radiograph*

Generalized medium crepitations and rhonchi	...	...	...	...	6
Generalized rhonchi only	...	...	...	...	13
Bilateral basal crepitations	...	...	...	...	10
Localized fine crepitations	...	...	...	...	15

#### *Duration of Physical Signs and Extent of Disease*

Duration of Physical Signs	EXTENT OF DISEASE		
	Small	Medium	Considerable
Under 5 days ... ..	3	2	Nil
5-10 days ... ..	5	11	5
10-15 days ... ..	3	3	2
15-30 days ... ..	2	2	4
Over 30 days ... ..	2	Nil	2
No physical signs ... ..	12	5	3

*N.B.*—Comparison of the figures for duration of abnormal physical signs with those for duration of radiological abnormalities shows that there is a considerable gap in time between the two and therefore the clinical findings are not a reliable guide to radiological resolution. Hence the advisability of clearance radiographs of the chest in all cases.

#### *Extent of Radiological Disease in Relation to Physical Signs*

	EXTENT		
	Small	Medium	Considerable
Number with abnormal physical signs ...	15	18	13
Number with no abnormal physical signs ...	12	5	3

*Cases with Radiological Changes*

## Duration of stay in hospital :

Less than 12 days	...	...	...	...	...	9 cases
12-14 days	...	...	...	...	...	10 cases
15-21 days	...	...	...	...	...	13 cases
22-28 days	...	...	...	...	...	12 cases
28-42 days	...	...	...	...	...	14 cases
Over 42 days	...	...	...	...	...	8 cases

Ten patients were transferred to convalescent depot, six with some residual radiographic changes and four without. They were kept there for between 14 and 28 days. All were then readmitted to the Connaught Hospital and in all but two cases the chest radiographs were clear.

Since the duration of stay in hospital depended on the duration of radiological abnormality or of abnormal physical signs, in such cases there was a correlation between duration off duty and extent of disease, namely :

Disease of small extent	...	...	Average : 18.0 days (off duty).
Disease of medium extent	...	...	Average : 28.0 days (off duty).
Disease of considerable extent	...	...	Average : 29.0 days (off duty).

*Epidemiology of Cases with Radiological Changes in 65 out of 66 Cases tested serologically.*

	January	February	March	April	May
Influenza A	8	4	1	1	—
Influenza B	1	3	8	—	—
Psittacosis-L.G.V. group of viruses	—	—	2	2	—
"Q" fever	—	1	—	—	—
Cases with negative viral serology	8	6	13	6	1

*Extent of Radiological Changes in each Virus Group*

	Slight	Medium	Considerable	Totals
Influenza A	3	5	6	14
Influenza B	6	3	3	12
"Q" fever	—	1	—	1
Psittacosis-L.G.V. group	—	3	1	4
Negative serology	17	11	6	34
No serology (patient A.W.O.L.)	1	—	—	1
Totals	27	23	16	66

*Duration of Pyrexia**Groups 1 and 2*

	Afebrile	On admission only	24-48 hours	48-72 hours	3-6 days	Over 6 days	Longest (Days)	Remarks
Group 1	2	3	2	—	—	—	—	Nil
Group 2	10	23	44	17	15	3	9	48 hours or less —69% Over 48 hours —31%

*Comment.*—The maximum pyrexia was seen on the day of admission or the following day in almost all cases. Of those who were apyrexial, seven had had symptoms for 48 hours or more, but three had symptoms for less than 24 hours and were probably apyrexial throughout.

The temperature charts in these cases showed considerable variation. In the majority the temperature fell to normal on the morning following admission or 24 hours later, remaining normal or showing a slight rise on the following evenings. In some cases the temperature was normal within 24-48 hours, but rose again on the fourth or fifth day for a further 24-48 hours, giving a biphasic picture, more frequently seen in other groups. In other cases there was continuous pyrexia for up to five days, or a completely irregular intermittent pyrexia for a variable period.

Of the three cases with prolonged pyrexia, one had sinusitis, one had recurrence of tonsillitis after clearing; the other appeared to be resistant to treatment.

The patients without complications were apyrexial within 72 hours, and the temperature charts showed no special feature.

### Group 3

	Afebrile	On admission only	24-48 hours	48-72 hours	3-6 days	Over 6 days	Longest (Days)	Remarks
Group 3	4	7	14	12	8	2	8	48 hours or less —53% Over 48 hours —47%

*Comment.*—The pyrexia in this group differs from that in Group 2 in a slightly lower number reaching a maximum of over 102° and in a definitely longer duration of pyrexia. The latter is probably due to a less marked response or no response to chemotherapy, which would be expected in this “non-bacterial group.”

A greater proportion of patients showed the biphasic curve mentioned, a slow lysis, or a more prolonged intermittent pyrexia, than in Group 2.

Of those pyrexial for over six days, one had definite bronchitis, the other had no apparent cause for the prolonged pyrexia apart from delayed resolution of the pharyngeal exudate. The patients with complications did not have a characteristic temperature pattern, the height and duration of pyrexia being as follows :

Case	Maximum Height	Duration
1	101.2° F.	3 days
2*	103.4° F.	2 days
3	100.8° F.	3 days
4*	100° F.	3 days
5*	103.6° F.	2 days
6*	101.6° F.	4 days
7	99° F.	Admission only
8	100° F.	Admission only
9	99.8° F.	8 Days (bronchitic)

\* Patients with radiographic abnormality.

## Group 4

	Afebrile	On admission only	24-48 hours	48-72 hours	3-6 days	Over 6 days	Longest	Remarks
Group 4(a)	4	10	15	15	7	—	—	48 hours or less —57% Over 48 hours —43%

*Comment.*—In all but seven cases the temperature fell steadily to normal within 72 hours and remained normal. Five patients showed a biphasic temperature with a secondary rise on the fourth or fifth day. Two had an irregular intermittent pyrexia for six days. The patient with an abnormal radiograph had a temperature of 100 on admission only.

## Group 4(b)

	In whole group	Uncomplicated (39)	With radiographic changes (16)	No radiographic changes (12)
Afebrile ...	9	4	3	2
Admission only ...	5	3	1	1
24-48 hours ...	13	9	3	1
48-72 hours ...	16	12	1	1
3-6 days ...	17	10	4	3
Over 6 days ...	7	1	4	2
Longest ...	28 days	7 days	25 days	28 days
Average ...	4.6 days	3.1 days	6.6 days	5.6 days

Of the two patients who had abnormal chest radiographs but no abnormal physical signs, one was apyrexial and the other had pyrexia with a maximum of 102 for 5 days.

*Comments.*—The figures for maximum height of pyrexia show only a tendency towards a higher temperature in those patients with complications, with no very significant difference.

In duration of pyrexia, however, the difference is more marked, the average duration in those patients with radiographic changes being twice that in patients without complications. The average duration in those complicated cases with normal radiographs is misleadingly high, because this group is small and the duration in two patients was 28 and 13 days, the average with these omitted being only 3.4 days.

It has already been mentioned that clearing of physical signs was rapid in the latter group, and the duration of pyrexia was only slightly longer than in the uncomplicated group. These two patients had, respectively, tonsillitis developing on the ninth day, and persistent physical signs at the base of the lung.

*Type of pyrexia.*—Similar types of pyrexia were seen as in other groups. Most of the 17 patients with a pyrexia from three to six days had a biphasic temperature which fell to normal after 48 hours and then rose on the fourth or fifth day.

Other patients with prolonged pyrexia had an initial continuous fever for two to four days, followed by irregular intermittent fever.

## Group 4(c)

	Total Numbers	Uncomplicated	Complicated
Apyrexial ... ..	11	6	5
Admission only ... ..	15	11	4
24-48 hours ... ..	60	37	23
48-72 hours ... ..	43	19	24
3-6 days ... ..	44	23	21
Over 6 days ... ..	29	5*	24
Average ... ..	4 days	3 days	5 days
Percentage over 72 hours ... ..	36%	28%	45%
Longest ... ..	12 days		

\* One for 12 days, one for 14 days

	With abnormal physical signs only	With abnormal chest radiographs	Other complications
Afebrile ... ..	3	1	1
Admission only ... ..	4	—	—
24-48 hours ... ..	15	9	1
3-6 days ... ..	15	18	—
Over 6 days ... ..	5	16	3
Longest ... ..	10 days	28 days	22 days
Average ... ..	4 days	7 days	4 days
Percentage over 72 hours ... ..	37%	55%	37%

*N.B.*—In Group 4(c) the incidence of pyrexia above 102° F. was almost twice as high in the patients with abnormal chest radiographs as in the uncomplicated cases. Of those with abnormal radiographs and no abnormal physical signs, five had maximum pyrexia 100°-101° F., four had maximum over 102° F., and none was below 100° F. The duration of pyrexia was considerably longer in those cases with complications than in those without, especially in those with abnormal chest radiographs. Of the three patients with "other complications" who were febrile for more than six days, one had sinusitis and two had severe and persistent laryngitis.

*Types of pyrexia.*—These did not differ from those already described in Group 4(b). Five uncomplicated cases were febrile for from five to 12 days, but the average was the same (three days) as that given by Stuart-Harris for influenza and the maximum, excluding one case, was seven days, also the same as that given by Stuart-Harris (1953).

*Cases with Radiological Changes**Maximum Pyrexia classified according to Extent of Radiological Changes*

	Small	Medium	Considerable
Afebrile ... ..	1	1	—
Under 100° F. ... ..	4	1	—
100-102° F. ... ..	13	14	6
Over 102° F. ... ..	9	7	10
Highest ... ..	104° F.	104° F.	104° F.



Afebrile	Less than 24 hours	24-48 hours	48-72 hours	3-6 days	7-10 days	Over 10 days
2	4	12	16	11	7	14

### *Duration of Pyrexia in Different Extents of Disease*

		Small	Medium	Considerable
Apyrexial	... ..	1	1	—
On admission	... ..	2	2	—
24-48 hours	... ..	3	7	2
48-72 hours	... ..	10	3	3
3-6 days	... ..	4	4	3
7-10 days	... ..	3	2	2
Over 10 days	... ..	4	4	6

*N.B.*—It will be seen that the height and duration of pyrexia tend to be greatest in those cases with most extensive radiological evidence of disease, and a comparison of these figures with those in other groups shows a tendency towards a greater height and duration of pyrexia in those patients with radiological evidence of intrapulmonary disease than in those without. However, the difference is not sufficiently well marked for the nature of the pyrexia to be of any diagnostic value in distinguishing between individual cases with and without radiological abnormalities in the absence of abnormal physical signs.

### *Duration of Illness before admission to Hospital*

	24 hours	24-48 hours	48 hours	Longest	Average
Group 1 ... ..	7	1	—		
Group 2 ... ..	64 (56%)	29	19	7 days	1.7 days
Group 3 ... ..	23 (48%)	9	15	5 days	2 days
Group 4(a) ... ..	39 (76%)	9	3	7 days	1.4 days
Group 4(b) ... ..	37 (55%)	14	16	14 days	2 days
Group 4(c) ... ..	77	50	75	3 weeks	2.8 days

*N.B.*—All patients were admitted to hospital on the day of reporting sick, so that the figures are the same for the duration of symptoms before reporting sick.

### *Comments on these figures in Groups 2, 3, 4(a) (b) (c)*

*Group 2.*—The short history in over half of these cases is an indication of the rapidity of onset and the severity of symptoms.

Only 19 patients in this group had symptoms for more than 48 hours before admission and none of these was found to have complications, in contrast to the findings in other groups.

*Group 3.*—The duration of symptoms before reporting sick tends to be slightly longer in this group than in Group 2, probably because the symptoms were less severe. Of these patients with a history of less than 24 hours, only one had complications; of 24-48 hours three, and of those over 48 hours five had complications. This tendency towards an increase in the complications rate in those with a long history is also seen in Group 4.

*Group 4(a).*—The onset of symptoms in this group was usually rapid and the duration of illness before admission is correspondingly short. Of the three with a history of more than 48 hours, one had an abnormal chest radiograph.

*Group 4(b).*—*Incidence of Complications* : Less than 24 hours history, 33 per cent. (12 out of 37) had complications ; 24-48 hours history, 57 per cent. (8 out of 17) had complications ; more than 48 hours history, 56 per cent. (9 out of 16) had complications.

The incidence of complications is greatest in those with a previous history of more than 24 hours and this particularly applies to those with abnormal chest radiographs. This suggests that bed rest as early as possible in the illness may reduce the risk of complications.

	With abnormal chest radiographs	With abnormal physical signs and other complications	Total
Less than 24 hours' history (37) ... ..	5	7	12/37
24-48 hours' history (14) ... ..	3	5	8/14
More than 48 hours' history (16) ... ..	8	1	9/16

*Group 4(c).*—*Relation between Duration of Illness and Incidence of Complications.*

	With abnormal chest radiographs	With abnormal physical signs only	Total
Less than 24 hours' history ... ..	12	23	35/77
24-48 hours' history ... ..	13	13	26/50
More than 48 hours' history ... ..	19	21	40/75
Average ... ..	3.5 days	2.7 days	3

*Uncomplicated Group.*—Less than 24 hours' history, 42; 24-48 hours' history, 24 ; more than 48 hours' history, 35.

*Total Incidence of Complications.*—Less than 24 hours' history, 45 ; 24-48 hours' history, 51 ; more than 48 hours' history, 53.

*N.B.*—In more than one-third of the patients of this group, symptoms were of longer than 48 hours' duration. There is a slightly greater incidence of complications, especially of abnormal chest radiographs, in those with the longer histories.

*Duration of Stay in Hospital.*

	Average	Minimum	Maximum	Remarks
Group 1 ...	7.2 days	5 days	11 days	One case kept for 11 days because of persistent nasal catarrh. The others were kept for four days after they were known to be afebrile.

	Average	Minimum	Maximum	Remarks
Group 2 ...	7.4 days	5 days*	16 days	Ten cases over 10 days. Normal routine was for all cases to be kept in bed for 48 hours after they were afebrile. After 48 hours up they returned to their units to be excused duty for three days or longer at discretion of unit M.O.
Group 3 ...	8.8 days	6	27	

\* Excluding one with chronic bronchitis—28 days

With radiographic abnormality. Average 19 days (27). With abnormal physical signs : Average 9.6 days. Uncomplicated group : Average 8.1 days.

*N.B.*—The same routine was followed of keeping patients in bed for a minimum of 48 hours after they were apyrexial, followed by 48 hours getting up. Some patients were retained for a longer period if there was persistent evidence of catarrh or pharyngeal exudate. Even in the uncomplicated group the length of stay in hospital was longer than in Group 2 as the response to treatment was less dramatic. Those patients with complications were kept in hospital until their chests were clear clinically and radiologically and they were free from symptoms.

As a routine of discharge from hospital, all patients were recommended to be excused duty for three days.

	Average	Minimum	Maximum	Remarks
Group 4(a) ...	7.6 days	5 days (2)	11 days (1)	Since complications were few there was little variation in the duration of stay in hospital. Patients were kept in bed for 48 hours after becoming afebrile. After 48 hours up they were to be excused duty for three days unless symptoms persisted.
Group 4(b) ...	13.7 days			These figures do not include the period spent in convalescent depot. Four patients in this group were sent to convalescent depot, three for two weeks and one for a month. Three of these had some residual shadowing on radiographs. On return to hospital radiological opacities had not cleared completely in two cases. These were returned to unit in category P.7 and to have a radiograph of the chest every month. Uncomplicated cases, as in other groups, were retained in hospital for four days after becoming afebrile and on return to unit were recommended to be excused duty for three days.
Uncomplicated group ...	8.8 days	5 days (3)	19 days	
Complicated group ...	20 days	7 days	63	

Group 4(c) : Average 11.4 days.

Uncomplicated group : Average 9.4 days ; maximum 24 days ; minimum 5 days (three patients).

Complicated group : Average 13.4 days ; with radiographic changes 25 days ; with physical signs only 11.3 days ; maximum 55 days ; minimum 6 days (six patients) ; with radiographic changes nine days.

*N.B.*—In addition to the above periods, seven patients were sent to the convalescent depot for a further period of 14-32 days. These were all patients who had a severe illness with abnormal chest radiographs. In four patients there was some residual shadowing at the time of transfer, but all were clinically and radiologically clear at the end of their period of convalescence.

In this group the duration of stay in hospital of uncomplicated cases is longer than in other groups. The usual routine of keeping patients for four days after they became afebrile was followed, but a considerable number of patients had catarrhal symptoms after they became afebrile and such patients could not be returned to their units until they were free from catarrh. On discharge to unit all patients were recommended to be excused duty for three to five days as a start.

### TREATMENT

In all cases of coryza, treatment was essentially symptomatic on the usual lines.

In all other groups parenteral penicillin was exhibited. In Group 2 this resulted in rapid clinical improvement. Penicillin appeared to be of benefit in the complicated cases in Group 3 and Groups 4(a), (b) and (c). It also appeared to be of value as a bacterial prophylactic in the uncomplicated cases in Group 3 and Groups 4(a) and (c).

All cases with radiological changes received, in addition to parenteral penicillin, hot water mixture, percussion postural drainage and breathing exercises. The results of treatment appeared to be satisfactory and, although in some cases resolution was slow, all ultimately cleared completely.

### DISCUSSION

We encourage medical officers to refer cases such as these to hospital in the first place as U.R.T.I. instead of coryza, nasopharyngitis, tonsillitis, pharyngitis, laryngitis, laryngotracheitis, tracheo-bronchitis, influenza, etc., as all such provisional diagnoses are not normally very informative.

U.R.T.I. is a good group provisional diagnosis which stimulates adequate investigation, thus tending to measures which exclude other diseases—some serious—which may masquerade as U.R.T.I. as classified here.

Group 1 consisted of cases of the common cold, a mild illness which doubtless accounted for the small number (eight) in this series. None in the series showed abnormal radiological findings, but that does not mean that others who were not admitted to hospital did not have pulmonary opacities which could have been demonstrated radiologically. For fear of pulmonary phenomena in such cases one worker forbids cross-country runs or any other form of vigorous exercise in individuals suffering from coryza.

Group 2 consisted of cases diagnosed as bacterial sore throat because, in our opinion, the only point of difference from streptococcal sore throat was our inability to culture  $\beta$ -hæmolytic streptococci from throat swabs. Treatment with penicillin was beneficial and would appear to be the best treatment to date.

We could recognize cases of febrile catarrh with exudate and confirm the view of Stuart-Harris that such cases with exudate are never influenza.

Treatment of these cases was essentially symptomatic. Penicillin therapy in this group was beneficial in the complicated cases and would appear to be indicated initially as a bacterial prophylactic and so lessen the incidence of complications.

In Group 4(a) the benefit of penicillin therapy was doubtful and treatment was essentially symptomatic. The same remarks apply to the treatment adopted in Group 4(b) and to cases in Group 4(c) without complications or radiological abnormalities. These latter would appear to have benefited in a relative manner from penicillin therapy. Expectoration when present never became purulent or even muco-purulent to the naked eye. That is what we mean by the relative beneficial effects of penicillin therapy.

We believe that the most interesting features of this investigation are the high incidence of pulmonary opacities demonstrable on radiographs, their ætiology, their nature and character as well as their management. The case in Group 2 will doubtless be regarded as a manifestation of febrile catarrh.

Three cases in Group 3 with pulmonary opacities were not detected clinically, but the fourth case was detected clinically as atelectatic consolidation of the right lower lobe.

The remaining 61 cases out of a total of 66 occurred in Groups 4(a), (b) and (c), *i.e.*, 92.42 per cent. of all cases with pulmonary disease demonstrable on radiographs. Furthermore 60 out of 66 cases occurred in 269 cases comprising Groups 4(b) and (c). In other words, 22.3 per cent. of all cases in groups 4(b) and (c) had pulmonary opacities. There should be little difficulty therefore in recognizing the groups of cases in which the majority of pulmonary opacities occur.

What is the nature of the pulmonary opacities and how are they produced? Probably in the absence of serology the majority of such cases would have been diagnosed as "virus pneumonia" or "influenzal pneumonia," and no one could quarrel severely with such diagnoses. However, some would have inevitably been referred to as "primary atypical pneumonia," a term which we have already defined and which we mention only to ignore from now on. Others would have been called "aspiration pneumonia," which they most certainly were not. In the cases with productive cough, and these all had penicillin therapy, the sputum to the naked eye never became purulent or muco-purulent. Normally it was mucoid, excessively tenacious, elastic and remarkably adhesive.

Experience of seeing patients trying to cough up and spit out this material as well as to wipe the mouth clean from this remarkably tenacious and adhesive material gave us insight as to what was going on in the air-passages lined, and in some cases occluded, by such material. We could visualize that on expiration, as the air-passages shortened and narrowed, the lumina, especially at the periphery, could become occluded and that the process could continue in extent in varying degree, thus giving rise to lobar atelectasis, segmental atelectasis, zonal atelectasis or small areas of atelectasis of varying size producing appearances described as

mottling. By atelectasis we mean airlessness associated with diminution of volume. In these cases it would probably be more correct to describe the lesions as atelectatic pneumonia, although adhesive bronchial pneumonia would be more descriptive.

We do not doubt that aspiration phenomena occur in certain conditions, but not in the cases described here. We appreciate that some use the term aspiration pneumonia—wrongly we believe—to describe cases such as we have described, fully appreciating that the lobar, segmental or subsegmental atelectasis is the result of catarrhal processes occluding air passages of varying size essentially due to local conditions. If the majority of the radiological changes are essentially due to the occlusion of air passages by the exceedingly tenacious, elastic and adhesive mucoid material which lines their walls, it is not difficult to appreciate the view that in those cases with unproductive or scantily productive cough bronchiectasis may be a sequel. Hence the reasons for hot water mixture and percussion postural drainage in all such cases.

Some cases with radiological opacities were evident on routine physical examinations of the chest. Nevertheless many would have been missed and completely unsuspected. However, factors suggesting radiological investigation in some cases included height and duration of pyrexia, pleural pain and leucocytosis.

It is felt that there is too great a tendency to diagnose cases as "pneumonia." This term is usually used to designate what is normally a febrile illness with clinical and/or radiological signs in the chest without giving any clue as to the ætiology of the illness and the true nature of the pulmonary lesions.

If the diagnosis of pneumonia were discouraged and all febrile cases approached, investigated and assessed as they could be in hospital, then we feel that certain diseases hiding behind the vague diagnosis of pneumonia would come to light. We fully appreciate that not every febrile case should have a radiograph of the chest and that such an investigation is not normally necessary. However, we do feel that in febrile cases with radiological changes in the chest the question of blood culture, blood films and thick drops, white cell counts, serology, stool and urine culture as well as sputum and other examination should be considered as a matter of course, particularly overseas and in those returning from tropical service.

A close watch should also be kept for evidence of icterus, splenomegaly, lymphadenopathy and hepatomegaly as well as for a rash. The case of small-pox first regarded as a case of "pneumonia" can lead to death just as can the case of pneumotypoid.

Leptospirosis, tuberculosis, and even carcinoma among others must not be forgotten.

#### SUMMARY

Of 500 consecutive cases admitted as U.R.T.I. to a military hospital between 15th January, 1953, and 5th May, 1953, 13 were diagnosed as follows : Infectious mononucleosis, 6 ; herpetic stomatitis, 1 ; rheumatic fever, 1 ; rubella, 1 ;

transverse myelitis, 1; scarlatina, 1; malaria (M.T.), 1; tuberculous pleural effusion, 1.

The remaining 487 were classified as follows: (1) Common cold, 8; (2) bacterial sore throat, 112; (3) febrile catarrh with exudate, 47; (4) influenza-like illness with (a) no catarrh, 51; (b) minimal catarrh, 67; (c) marked catarrh, 202.

Every case had a radiograph of the chest on admission and serological reactions were carried out on 65 out of 66 cases with positive radiological findings. The nature of these latter is described.

Sixty of the 66 cases with radiological changes occurred in Groups 4 (b) and (c); *i.e., more than one in five.*

All groups are assessed from the serological, hæmatological, bacteriological and radiological point of view.

The effect of treatment is discussed.

In some cases the term "adhesive pneumonia" or, even better, "*adhesive bronchial pneumonia*" should replace "aspiration pneumonia."

The radiological appearances are those found in respiratory virus infections but are not peculiar to any one virus.

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## No. 1 MOBILE MILITARY HOSPITAL

BY

Colonel C. R. CROFT, T.D., D.M., M.R.C.P.

### ORIGINS

ACCORDING to a pamphlet found in one of the lorries which arrived in Egypt in 1941, the American Field Hospital Corps Inc., of 610 Fifth Avenue, New York, which had previously supplied 100 ambulances to the French Army, decided, following the French Armistice, upon the immediate construction of a Mobile Field Hospital for the relief of civilian war victims in Europe. This hospital was designed by Mr. Charles Butler, of Butler & Kohn, New York, and constructed under the direction of John W. Harris Associates. It was formally dedicated on 8th November, 1940, and presented to the British Hospitals Association. I understand that it was then made over to the War Office and was shipped to the Middle East from America. The War Office made out a war establishment for it, which was sent to G.H.Q., Middle East, under the title of a Mobile Military Hospital.

In June, 1941, I was appointed to command of No. 24 C.C.S., which had returned without equipment from the campaign in Greece earlier in the year. After some weeks of fruitless efforts to collect the equipment of a C.C.S. in the Canal Zone, I was summoned to G.H.Q. and instructed to collect from the ports an assortment of American vehicles, and to gather these and my unit at Helmieh. Despite a certain amount of camouflage, all were finally identified and brought in. They consisted of :

- 6 × 3-ton cargo trucks.
- 1 × 30-cwt. van.
- 1 fuel truck in 300, 200 and 100 gallon sections.
- 3 × 600-gallon water trucks.
- 1 machine shop truck.
- 1 refrigerator van for provisions.
- 1 biological laboratory van.
- 2 ambulances (too short for Army stretchers).
- 1 kitchen trailer.
- 1 steam boiler trailer (4 wheeled).
- 1 toilet and shower bath trailer.
- 1 electric power trailer with 2 × 4 Kw. and 1 × 1½ Kw. generators.
- 1 trailer containing sterilizing equipment.
- 1 trailer fitted to take surgical instruments and supplies.

In the lorries was found an assortment of tentage, beds and metal work. No blue print was found.

The officers set to work to sort out this equipment and discovered :



1. Nine ward tents of singularly simple and efficient design, rather similar to the ridged double tent but much larger. The inner roof and walls with windows were in one piece, and the end flaps were generously cut, which proved invaluable for black-out (Fig. 1). These tents required the addition of weather lines. Two tents placed end to end made an excellent 25-bed ward with space for a duty room. They were very capacious for their weight, easily handled and repaired, and stood up to two years of very heavy wear and weather in the desert. I have never seen better tents for their purpose, and their use in any similar campaign in the future is very strongly recommended.

2. One hundred and ten aluminium bedsteads, with six legs and folding in the middle. They were light, easily packed, and lasted for three years without serious damage. Although light they seemed much less liable to damage in transit than the usual Army bedstead.

3. Operating Theatre. This remarkable structure formed an operating theatre for two or three tables, of great efficiency and preferable to any indoor theatre that we met on our travels. It could be in action in from three to four hours, and it occupied one lorry when dismantled. It was constructed as follows :

Four girders (each from two half-girders bolted together) with jacked feet at each end for levelling and normally standing on these about 18 inches from the ground, with end members uniting these girders to make an oblong on which a wooden sectioned floor in eight pieces was laid. On this rolls of rubber flooring were later laid to form the floor of the theatre. From the longer sides of the girder frame four arches of tubular steel were erected, united at the eaves and summit by further tubular metal. Over this framework a canvas cover was drawn and fastened at floor level (Fig. 2). This canvas cover had four apertures, one on each side. One of these was filled by a hinged canvas door in a metal frame, which formed the entrance to the theatre; one was closed by a short tubular piece of canvas which gave entry to the interior of the X-ray lorry backed against the opening ; the third was similarly closed by the back of the surgical instrument trailer ; and the fourth by the back of the sterilizer trailer. All canvas unions were secured by closely spaced clips to the theatre walls and backs of the vehicles after the doors had been clipped back. Short ramps completed the entry from the theatre to the vehicles. Over the main canvas of this pavilion a further canvas roof was stretched, and an inner wall of washable material was also provided (Figs. 3, 4 and 5).

A very large canvas porch capable of holding three or four stretchers (Fig. 3) for patients waiting or leaving the theatre was made to enclose the main entrance. This also solved the problem of black-out.

The X-ray lorry contained a small portable X-ray unit which never failed us. Power for this was provided from the  $1\frac{1}{2}$  Kw. generator in the electric power truck.

The surgical equipment trailer was beautifully fitted with cupboards and drawers which made the storage and handling of instruments and dressings a very simple matter.

The sterilizer trailer contained a four- or six-drum sterilizer (I forget which

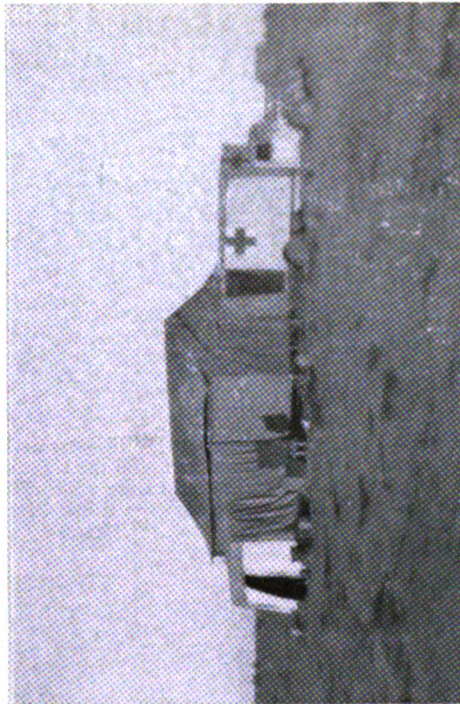
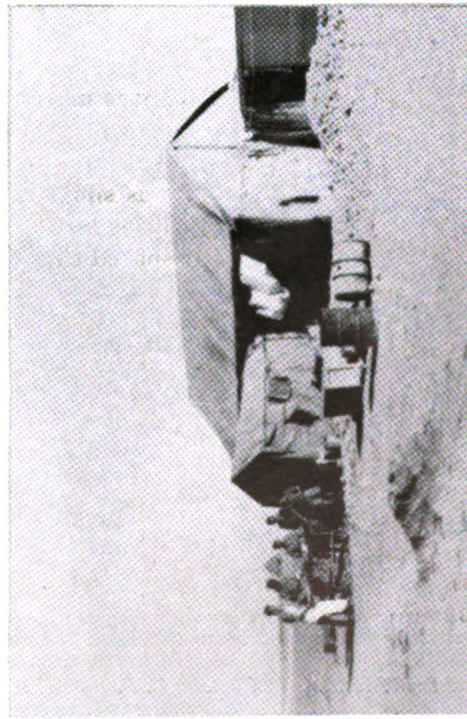
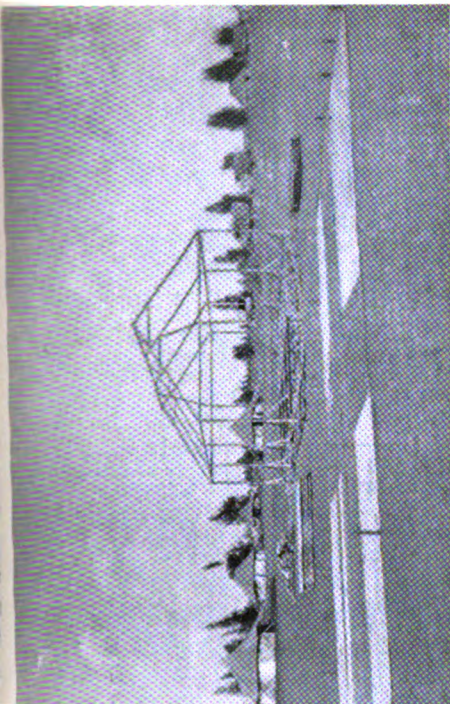


Fig. 1. *Top Left* : A 25-bed Ward dug and blasted in to bed level at Bardia. Note : M.A.C. delivering to Ward and not dumping at admission.

Fig. 2. *Top Right* : The framework of the Operating Theatre showing girders to support the floor, tubular metal to support wall and roof canvas (no central supports). The men are seen handling the floor sections.

Fig. 3. *Bottom Left* : Operating Theatre fully erected with commodious well blacked out porch, in which 2-3 stretchers can be placed. On the right the X-ray van with doors turned back and connected to theatre by short canvas tube.

Fig. 4. *Bottom Right* : Operating Theatre with porch and X-ray van.





Fig. 5. Operating Theatre (back view). On extreme left is canvas connection to X-ray van. In the left centre is the sterilizing van. To the right of this and connected by flexible steam piping is the steam-boiler trailer, and to the right of this and connected by a pipe is a water tanker. Behind the boiler can be seen the surgical instrument and dressings van, connected (like the X-ray and sterilizer vans) to the Theatre by a wide, short canvas tube.



Fig. 6. Dispensary cum Laboratory with adequate water supply and sink. These fittings were later transferred without difficulty to a standard 3-ton truck. Captain (now Lieut.-Col.) J. P. Baird at work.

*Thanks are due to Lieut. (now Captain) L. S. Brooks, R.A.M.C., for the photographs. He took either these or better ones.*

but think it was six), an instrument sterilizer, and a large bowl sterilizer. The sterilizer trailer (Fig. 5) was attached by flexible tubes to the steam boiler trailer which stood nearby. This consisted of a boiler heated by a forced air draught behind paraffin burners, the draught fan being worked from the generators. This boiler provided high pressure steam for sterilizers, low pressure steam for steam heaters in the operating theatre and also running hot and cold water for the wash basin, which was placed in the theatre when enough water was available. This steam boiler trailer usually required to have a water truck attached to it. It was managed and maintained by one sapper private, it survived two years in the Desert and one in Italy, and was in good condition then.

Theatre lighting was from three good lamps on stands, one of which had an emergency accumulator with trickle charger. This, and the lighting of all wards and departments, was supplied from the main generators.

#### MODIFICATION : THE VEHICLES

1. *Prime Movers*.—The fuel truck was earmarked to carry paraffin for the steam boiler owing to probable difficulty in getting further supplies in the field.

The three water trucks proved valuable in providing a water reserve and in collecting water in bulk. The filling pumps were worked off the engines. They were also extremely good vehicles for towing broken-down trucks in emergency.

The machine shop truck was provided with welding gear, electric drills, etc., and played a most valuable part in maintenance of vehicles and equipment, and performed many major repair operations as well as carrying spare parts, tyres, etc.

The 30-cwt. truck was useful to the Quartermaster, whose conveyance it became.

The refrigerator truck found refrigeration in the Desert beyond its powers, but was a clean, safe, and efficient store for food and medical comforts.

The biological laboratory truck (Fig. 6) held the dispensary and its stores, and also served as a laboratory where many a malarial parasite was observed, and also the spirillum of relapsing fever.

The two ambulances were returned to ordnance.

2. *Trailers*.—It is axiomatic that no two-wheel trailers are of any use in the Desert ; they had either to be scrapped or put on a chassis. This did not apply to the steam boiler trailer which was on four wheels and remained and survived as a trailer. Although small it was very heavy, and nothing short of a 10-ton lorry could be relied upon to move it. The trailers were therefore modified as follows :

The kitchen trailer was put on the chassis of a 10-ton Mack lorry which was fitted to tow the steam boiler. The bodies of the electric power trailer, sterilizer, and surgical instrument trailer were put on to the chassis of 3-ton lorries. The toilet and shower-bath trailer was, regretfully, left in the hands of G.H.Q. It was not very sanitary in design.

3. *Additions*.—The war establishment was designed to provide for a hospital of 110 beds which could move in one lift on its own transport. Roughly, this provided in personnel : C.O., surgical specialist, anæsthetic specialist, graded

surgeon, dental surgeon as maxillo facial specialist, two general duty officers, one quartermaster and seven nursing sisters. O.Rs. : R.A.M.C. 60, R.A.S.C. 40, R.E. 3. Furthermore, it was made clear that the unit was always to provide for 110 beds plus 90 stretchers as a basis. It was clear that our load-carrying capacity was inadequate, and our full W.E. included ten 3-ton trucks. These were acquired with some difficulty, and the unit took to the field with the following vehicles:

- 10 × 3-ton trucks.
- 4 × 4 stretcher motor ambulances.
- 2 × 4-seater cars.
- 1 × 30 cwt. van.
- 1 × 600-gallon fuel truck (American gallons).
- 3 × 600-gallon water trucks (American gallons).
- 1 machine shop van.
- 1 laboratory and dispensary van.
- 1 X-ray laboratory van.
- 1 electrical power van.
- 1 sterilizing van.
- 1 surgical equipment van.
- 1 provision van.
- 1 kitchen van, 10-ton Mack.
- 1 steam boiler trailer.
- 2 motor cycles (soon abandoned).

With minor modifications this establishment was adequate. It meant extreme parsimony in personal equipment, and it meant that the vehicles were invariably overloaded, especially when one considers that it is inadvisable in the Desert to load a 3-ton lorry with more than  $2\frac{1}{2}$  tons of contents. On the personnel side, 60 R.A.M.C. is inadequate for 200 beds and stretchers, and the work would not have been possible without the staunch help of the men of the R.A.S.C. when the hospital was stationary. The Sisters joined the unit only during the latter part of the campaign, and they used the cars or ambulances during transit for themselves and their kit.

### *Distribution of Equipment*

The lorries were loaded as follows :

Each of four contained the full equipment of one 25-bed ward—tentage, beds, bedding, nursing gear, paraffin heaters, etc. One contained an officers' ward of 10 beds plus tentage and stretchers for expansion. One contained the operating theatre. One contained office equipment plus general stores. One contained sanitation gear. One contained vehicle spares and general equipment. One contained extra kitchen gear and general equipment (quartermaster). A lorry was later devoted to a resuscitation ward. Specialist equipment was carried in associated vans, *i.e.*, theatre tables in the surgical equipment van, theatre lighting in the X-ray van, electrical gear, cable, lights, etc., in the generator van, medical stores in the dispensary van, etc.

The personnel detailed to wards and departments travelled in the lorries associated with their detail and equipment was on charge to the senior N.C.O. or man whether the equipment was loaded or in use. The quartermaster only dealt with the equipment for checking, repair, and replacement. This meant that the same men always had the same gear. It was up to them to look after it and they took great pride in doing so; they never felt that they were getting gear which had been damaged by others. Damage and losses were extremely small.

### *The Net Result*

This unit was capable of getting into action with a fully functioning theatre and 110 beds plus 90 stretchers in half a day. It could pack up and move also in half a day, provided it was not, as was so often the case, expected to accommodate 300-400 patients, and having to evacuate at the same time. It could travel in one lift between 100 and 150 miles a day and was equal to desert as well as road travel. It could provide unequalled surgical facilities for at least two surgeons working at the same time. Its basic equipment met the requirements of expansion to 300-400 patients if further tents and stretchers and personnel were provided. On several occasions it met a very much higher demand.

A serious criticism of the unit was that the loss of one of the theatre vans would seriously cripple the unit. This criticism was very much overstated, and in fact, it never happened as provision was always made for emergency towage. The same criticism could be made against the loss by any unit of its sterilizer, X-ray plant, surgical instruments, or generator. Moreover, it was found at the end of the Desert campaign that the engines of the specialized vans were worn out, but it was a simple matter to transfer the entire specialized equipment (except X-ray) to standard army lorries, and with these we continued to operate throughout the Italian campaign.

### *Did it Work?*

The preliminary staff prognostication was not borne out by events, and it is important to judge whether the unit worked effectively.

The unit left the Delta in October, 1941, and returned there in June, 1943.

My quarterly report at the conclusion of the Desert campaign records the following details :

Days in the field	...	...	...	619
Days in transit	...	...	...	126
Total distance travelled	...	...	...	5,759 miles
Number of patients admitted	...	...	...	17,047
Number of patients staged (so far as recorded)	...	...	...	4,478
Total				21,525

Average daily admission : 34.7 (when open)

*Was it Desert-worthy?*

In our first advance it travelled entirely by desert from Mersa Matrouh to the South-West and did not regain the road until reaching El Adem. In the final advance it left the road at Sirte and did not reach it again until just south of Tripoli, having followed the Armoured Division to the south of Wadi Zemzen and then north through Beni Ulid.

*Was it Reliable?*

The unit never failed to keep an appointment, whether by desert or road, by day or night travel throughout the North African or Italian campaigns. This I think established its mobility. It did not lose any vehicle or other item of equipment in retreat, although situated south of Benghazi when the Germans broke through at Agheila, nor in the retreat from Bardia to El Alamein did it fail to arrive intact. It arrived intact at Sousse for the Enfidaville battle, in 1943, with the same transport with which it started the campaign in 1941.

*Was it Adaptable?*

The unit's own small establishment limits efficient treatment, at any rate, of serious cases to about 150, of less serious to 200, but several notable expansions took place. In November, 1941, at Minquar El Zannan the unit dealt with 329 battle casualties under canvas, and a further 215 in the ambulances in which they arrived at nightfall. In four weeks at Capuzzo, in May, 1942, it admitted 1,821 casualties. Shortly afterwards while evacuating 150 patients it closed and was ready to move within four hours of receiving the signal to do so. At Ben Gardane, in April, 1943, the unit held 300 battle casualties after sorting and staging 850 more. At Andrea, in June, 1944, the unit moved in with 130 patients and was holding 1,100 Yugoslavs in buildings within four weeks, many of them in a very ill condition. In one respect it may lack the adaptability of a simpler unit, and that is for beach landing. But it would be quite easy to establish simple tent surgery until conditions permitted the landing of the vehicles required for the main theatre.

On some occasions when large expansions were made, several surgical teams were attached to the unit ; indeed, the mess frequently contained more attached than unit officers. As these units required nursing and all unit needs, such as sanitation, cooking, etc., to be provided by the parent unit, very severe strain was often experienced from such attachments.

It should be emphasized that such a unit called for a high degree of team work and of specialized training in which R.A.M.C., R.A.S.C., and R.E. co-operated to a degree in excess of their usual functions. For example : a surgeon, only interested in surgery, was useless unless he was prepared to master the intricacies of his operating theatre and to supervise and train the team which erected it. It will be noted that there was no R.A.S.C. officer, and it is thought that direct control of the vehicles by the R.A.M.C. greatly facilitated the full use of the transport, especially in emergencies, as when all possible vehicles were required for evacuation or where priorities relating to breakdown had to be

considered. It also facilitated the use of R.A.S.C. in tent pitching and stretcher bearing. But it meant that an officer had to become familiar with the requirements of vehicle maintenance and inspection. Changes in personnel were at times most embarrassing to the unit. Every officer and man had to pull his weight, and the unit was most fortunate in having men who were able and willing to make it succeed despite the suspicion with which the capabilities of so unorthodox a unit were regarded by many with whom it came in contact.

It is not my intention to brag of these achievements, which I do not pretend are greater than those of others. They are recorded to show that a unit establishment for 100 beds, with very modest transport which imposed a limit to its capacity of men and material, was able to show such a scale of mobility and expansion as to meet major requirements in warfare and to provide a standard of surgical facilities which I believe was unequalled.

### *Can it be simplified?*

It was considered at the outset to be too refined and delicate to withstand the rigours of war, and indeed the view was expressed in responsible quarters that it would never reach its first location. This view regarding its vulnerability was never, so far as I am aware, withdrawn. Indeed, despite its continued survival, varying specious explanations for this were produced without any admission that it might indeed be tougher than it appeared. One must admit, however, to a large element of luck, and a reduction of this factor is desirable and could be achieved.

Basically, the theatre is a simple structure which could be reproduced in bulk with replacement parts. The principle of backing fitted vans to open into it should be preserved. The process of crating and uncrating technical equipment is time consuming and injurious to equipment. (The unit scarcely carried a single crate). Proper fittings of drawers and cupboards is of the greatest value with delicate gear. It would be possible to construct simple van bodies which could be fitted on to the chassis of standard army lorries. Less effective would be to provide such fittings which could be—and indeed were—transferable to any standard lorry, and firmly fixed there; this applies to the sterilizer and instrument vans. The other vans used for generators, provisions, kitchen, etc., are replaceable by lorries, but the workshop and the dispensary-*cum*-laboratory vans should, if possible, be preserved.

No one who saw or worked in this unit failed to recognize that the surgical facilities it offered were superior to any E.P.I. type theatre or even to the old "tent, operating", and it would be a pity if it came to be forgotten when preparations are made for future requirements.



# STUDIES ON THE RAPID PRODUCTION OF A NON-SPECIFIC TYPE OF IMMUNITY TO *SALMONELLA TYPHI* INFECTION IN MICE

BY

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THE lethality of *Salmonella typhi* for mice is greatly reduced if the bacilli are injected subcutaneously instead of intraperitoneally. It seemed of interest to investigate the possible protective value of subcutaneous immunization with sub-lethal doses of living typhoid bacilli against a subsequent fatal dose administered intraperitoneally. During some preliminary experiments with the classical Ty2 strain, it was found that a high degree of immunity was attainable by this procedure. For example, 56 days after being immunized subcutaneously with  $250 \times 10^6$  live Ty2 bacilli, 15 out of 20 mice were able to withstand an intraperitoneal challenge of 3 LD<sub>100</sub> ( $240 \times 10^6$ ) of the homologous organism.

During these investigations it was noticed that resistance to infection began to increase as soon as 4 hours after subcutaneous immunization, long before antibody production could reasonably be expected to commence. The present communication describes various experiments relating to the production and characteristics of this precocious type of resistance to *Salm. typhi* infection in mice.

## MATERIALS AND METHODS

*Strains of Bacteria.*—The following were used: *Salm. typhi* strain Ty2, *Salm. paratyphi A* strain HA6, *Salm. paratyphi C* Kauffmann East Africa strain, *Salm. cholerae-suis* var. Kunzendorf, *Shigella flexneri* type 6 (strain 94/52) and *Escherichia coli* O<sub>111</sub>B<sub>4</sub> (D.433).

*Bacterial Extracts.*—The freeze-dried preparation of *Esch. coli* (CV) cell walls used was kindly supplied by Dr. D. Rowley of the Wright-Fleming Institute of Microbiology. We are indebted to Dr. D. A. L. Davies of M.R.D. Porton for the somatic antigen (endotoxin) of *Sh. dysenteriae* type 1 (Shiga) which had

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a mouse LD<sub>50</sub> of 100 $\mu$ g. Both substances were suspended in physiological saline immediately prior to injection.

**Preparation of Live Bacterial Suspensions.**—Cultures were inoculated on to a Difco nutrient-agar plate and incubated for 12 hours at 37° C. Six smooth opaque colonies were selected, emulsified in physiological saline and used to inoculate Difco agar slopes. After 12 hours at 37° C. the growth was washed off with saline and the bacterial concentration estimated by comparison with Brown's standard opacity tubes. Dilutions were made with saline as required. A bacterial count was performed in triplicate on all challenge and live immunizing inocula by the method of Miles and Misra (1938), and the result expressed as a percentage of the previously estimated density. The antigenic composition of all bacterial suspensions was confirmed by routine agglutination tests.

**Preparation of Killed Bacterial Suspensions.**—Organisms harvested from Difco agar slopes, as above, were suspended in 75 per cent. alcohol overnight, washed three times and finally suspended in saline. The bacterial concentration was estimated, and routine agglutinations performed, as with the live suspensions.

**Animals.**—Both Webster and Strong A strains of albino mice were used during the experiments. It was not possible to use animals of one strain only throughout, but in each separate experiment the mice were of the same strain. No significant difference in the development of non-specific immunity by Strong A and Webster mice was detected in a control experiment not described in the text. The animals used varied in weight from 18-25 grams, although for each experiment mice of approximately the same weight and age were used. The sex was either constant for an experiment or both sexes were similarly distributed among directly comparable groups. All animals were fed throughout on diet 41 (Bruce, 1950).

**Routes of Inoculation.**—Subcutaneous injections were made in the interscapular region. Volumes of 0.5 ml. were used constantly both for this route and for intraperitoneal inoculations. Intravenous injections with a constant volume of 0.25 ml. were made into a tail vein.

**Duration of Observation.**—Mice were observed for 48 hours after receiving a challenge dose of *Salm. typhi* and for 6 days after a comparable dose of *Salm. paratyphi* C. Whereas *Salm. typhi* exerts a rapid pathological effect in mice attributed to the accumulation of endotoxin following large inocula, *Salm. paratyphi* C can produce a true infectious process when introduced in small numbers as well as the early "toxic" effect with large doses.

**Detection of Antibody Production in Mice.**—Blood was obtained from animals in groups of five and pooled. The serum was separated and examined for the presence of "O" and "Vi" agglutinins following the method of Felix and Bensted (1954).

## RESULTS

### *Subcutaneous Immunization with Living Bacteria.*

Mice began to develop resistance to the intraperitoneal injection of *Salm. typhi* strain Ty2 as early as 4 hours after subcutaneous immunization with

three times the dose of the same live strain. Table I contains the collated results of three separate experiments which show the degree of immunity in mice when the period elapsing between subcutaneous immunization and subsequent challenge varied from 0-168 hours. Substantial protection is afforded by 12 hours and is continued without falling off right up to the seventh day. An additional five mice were added to all groups in A and B of Table I and were killed at the same time as the challenge of the other 20 animals in the group. The pooled serum from these animals was examined for "O" and "Vi" antibodies against *Salm. typhi*, but no group from 0-24 hours differed from control mouse serum in agglutinin content.

The extent of this early immunity is shown by Table II, where greater challenge doses were given 48 hours after a subcutaneous dose of  $150 \times 10^6$  living cells of Ty2. One third of the protected mice were able to survive as many as  $480 \times 10^6$  typhoid bacilli ( $6LD_{100}$ ) intraperitoneally—a dose which is rapidly and uniformly fatal to normal mice.

Maximum protection could be obtained against an intraperitoneal challenge of  $80 \times 10^6$  *Salm. typhi* by a subcutaneous dose of only  $50 \times 10^6$  homologous bacilli 48 hours previously. If, however, this immunizing dose was reduced still lower, the protective effect was less marked (Table III), being just detectable after  $10 \times 10^6$  but not after  $10^6$  bacilli.

Rapid protection against a fatal intraperitoneal dose of *Salm. typhi* could also be obtained with heterologous Gram-negative bacilli. Table IV shows the

TABLE I.—THE DEVELOPMENT OF AN EARLY IMMUNITY TO AN INTRAPERITONEAL CHALLENGE DOSE OF *Salm. typhi* (Ty2) ( $80 \times 10^6$  BACILLI) FOLLOWING THE SUBCUTANEOUS INOCULATION OF  $250 \times 10^6$  LIVE HOMOLOGOUS BACILLI

Group A		Group B		Group C	
Interval between immunization and challenge (hours).	Number of survivors, (Numerator) Number of animals inoculated. (Denominator)	Interval between immunization and challenge (hours).	Number of survivors, (Numerator) Number of animals inoculated. (Denominator)	Interval between immunization and challenge (hours).	Number of survivors, (Numerator) Number of animals inoculated. (Denominator)
0	2/20	12	17/20	24	20/20
2	2/20	14	13/20	48	17/19
4	8/20	16	14/20	72	20/20
6	10/20	18	15/20	96	20/20
8	12/20	20	17/20	120	19/19
10	14/20	22	20/20	144	20/20
12	14/20	24	16/20	168	20/20
Not challenged	18/20	Not challenged	18/20	—	—
Not immunized	2/20	Not immunized	6/20	Not immunized	0/20

Living bacterial counts :  
Immunizing dose :  
77% (of opacity estimation)  
Challenge doses :  
60-91% (of opacity estimation)

Mouse strain :  
Strong A (female)

Living bacterial counts :  
Immunizing dose :  
98% (of opacity estimation)  
Challenge doses :  
37-66% (of opacity estimation)

Mouse strain :  
Strong A (10 males and 10 females in each group)

Living bacterial counts :  
Immunizing dose :  
46% (of opacity estimation)  
Challenge doses :  
41-80% (of opacity estimation)

Mouse strain :  
Strong A (10 males and 10 females in each group)

TABLE II.—THE PROTECTIVE EFFECT OF LIVE *Salm. typhi* strain Ty2 INOCULATED SUBCUTANEOUSLY 48 HOURS BEFORE THE INTRAPERITONEAL ADMINISTRATION OF 3 AND 6 LD<sub>100</sub> OF THE HOMOLOGOUS ORGANISM

Immunizing dose of <i>Salm. typhi</i> (Ty2). Number of organisms.	Challenge dose of <i>Salm. typhi</i> (Ty2). Number of organisms.	Number of survivors. Twenty animals inoculated in each group.
150 × 10 <sup>6</sup>	240 × 10 <sup>6</sup>	14
	480 × 10 <sup>6</sup>	7
	Nil	20
Nil	240 × 10 <sup>6</sup>	0

Living bacterial counts :  
 Immunizing dose : 90%  
 Challenge doses : 113%  
 Mouse strain : Webster (male)

TABLE III.—THE PROTECTIVE EFFECT OF GRADED DOSES OF LIVE *Salm. typhi* (Ty2) INOCULATED SUBCUTANEOUSLY 48 HOURS BEFORE THE INTRAPERITONEAL ADMINISTRATION OF 1 LD<sub>100</sub> (80 × 10<sup>6</sup> BACILLI) OF THE HOMOLOGOUS ORGANISM

Immunizing dose of <i>Salm. typhi</i> (Ty2) (Number of organisms × 10 <sup>6</sup> ).	Number of survivors. Ten animals inoculated in each group.
60	10
50	10
40	7
30	9
20	5
10	3
1	0
Nil	0

Living bacterial counts :  
 Immunizing dose : 93%  
 Challenge dose : 73%  
 Mouse strain : Webster (female)

results obtained when mice were given 200 × 10<sup>6</sup> living cells of various Enterobacteriaceæ subcutaneously 1-8 days before an intraperitoneal challenge of 80 × 10<sup>6</sup> Ty2. When immunized with *Salm. paratyphi A*, *Sh. flexneri* type 6 or *Esch. coli* (O<sub>111</sub>B<sub>4</sub>) substantial resistance was obtained at 24 hours, which began to diminish after 3-5 days, and was negligible by 8 days. No falling-off in degree of immunity, however, occurs following protection with the homologous organism, for the stage of effective non-specific resistance merges imperceptibly into that of effective antibody production, which normally occurs on the fourth to fifth day. When given in a similar dosage, *Esch. coli* and *Sh. flexneri* produced slightly less resistance than *Salm. paratyphi A* and *Salm. typhi*.

TABLE IV.—THE EFFECT OF THE SUBCUTANEOUS INOCULATION OF VARIOUS LIVE ENTEROBACTERIACEÆ AT VARYING TIMES BEFORE THE INTRAPERITONEAL ADMINISTRATION OF 1 LD<sub>100</sub> OF LIVE *Salm. typhi* strain Ty2 (80 × 10<sup>6</sup> BACILLI)

Immunizing organism (Dose 200 × 10 <sup>6</sup> bacilli)	Number of survivors (numerator). Number of animals inoculated (denominator).								
	Interval between immunization and challenge (days)								Unchallenged
	1	2	3	4	5	6	7	8	
<i>Salm. typhi</i> (Ty2)	10/10	8/10	9/9	9/9	8/9	9/9	9/9	6/7	8/10
<i>Salm. paratyphi</i> A (HA6)	10/10	10/10	9/10	9/10	6/10	7/10	5/10	1/10	10/10
<i>Sh. flexneri</i> type 6	9/10	10/10	5/10	7/10	4/10	3/9	3/9	1/9	10/10
<i>Esch. coli</i> (O <sub>111</sub> B <sub>4</sub> )	8/10	7/10	5/10	4/10	2/10	1/10	3/10	0/10	10/10

0/10 unprotected mice survived the eighth day challenge dose of *Salm. typhi*

*Living bacterial counts :*

Immunizing doses

*Salm. typhi* 98%

*Salm. paratyphi* A 122%

*Sh. flexneri* type 6 60%

*Esch. coli* 64%

Challenge doses

*Salm. typhi* : 64-103%

Mouse strain :

Strong A (5 males and 5 females in each group.)

TABLE V.—THE PROTECTIVE EFFECT OF KILLED *Salm. typhi* strain Ty2 WHEN ADMINISTERED (a) INTRAPERITONEALLY AND (b) SUBCUTANEOUSLY 48 HOURS BEFORE RECEIVING VARIOUS LETHAL DOSES OF THE LIVING HOMOLOGOUS ORGANISM INTRAPERITONEALLY

Challenge dose of <i>Salm. typhi</i> (Ty2) (Number of organisms × 10 <sup>6</sup> )	Number of survivors. Ten animals inoculated in each group.		
	Immunizing dose of killed <i>Salm. typhi</i> (Ty2) 200 × 10 <sup>6</sup>		None
	Intraperitoneal	Subcutaneous	
80	10	0	0
160	10	1	—
240	10	1	—

*Living bacterial count :*

Challenge dose : 93%

Mouse strain :

Webster (male)

### Immunization with Killed Bacteria.

Rapidly produced immunity may also result from the intraperitoneal, but not subcutaneous, injection of killed bacilli. Table V shows that 100 per cent. of mice injected intraperitoneally with 200 × 10<sup>6</sup> dead cells of Ty2 can survive an intraperitoneal challenge of 240 × 10<sup>6</sup> (3LD<sub>100</sub>) 48 hours later, whereas the same immunizing dose given subcutaneously is without effect. Seven out of 10 mice survived 80 × 10<sup>6</sup> *Salm. typhi* strain Ty2 intraperitoneally when given only 10<sup>6</sup> of the same killed strain i.p. 48 hours previously. The lack of success using the subcutaneous route is paralleled by the non-toxicity of dead typhoid bacilli when given in this manner—as many as 10<sup>12</sup> organisms being necessary to kill mice.

TABLE VI.—THE PROTECTIVE EFFECT OF THE INTRAPERITONEAL ADMINISTRATION OF VARIOUS KILLED ENTEROBACTERIACEÆ (a) 48 HOURS AND (b) TEN DAYS BEFORE THE INTRAPERITONEAL INJECTION OF  $80 \times 10^6$  LIVE *Salm. typhi* (Ty2)

Immunizing organism (Dose $200 \times 10^6$ bacilli)	Number of survivors. Ten animals inoculated in each group. Time between immunizing and challenge doses.	
	48 hours	10 days
<i>Salm. typhi</i> (Ty2)	10	10
<i>Salm. paratyphi A</i> (HA6)	8	0
<i>Sh. flexneri</i> type 6	9	0
<i>Esch. coli</i> (O <sub>111</sub> B <sub>4</sub> )	7	4
Nil	0	1

Living bacterial counts :

48-hour challenge dose : 80%

10-day challenge dose : 95%

Mouse strain :

Strong A (female)

TABLE VII.—THE EFFECT OF THE SUBCUTANEOUS INOCULATION OF VARIOUS LIVE ENTEROBACTERIACEÆ ( $200 \times 10^6$  BACILLI) 48 HOURS BEFORE THE INTRAPERITONEAL ADMINISTRATION OF  $200 \times 10^6$  LIVE *Salm. paratyphi C* (KEA)

Immunizing organism dose ( $200 \times 10^6$ bacilli)	Number of survivors after various periods, following the administration of $200 \times 10^6$ <i>Salm. paratyphi C</i> (KEA) intraperitoneally. Ten animals inoculated in each group.		
	24 hours	48 hours	96 hours
<i>Salm. paratyphi A</i> (HA6)	10	9	1
<i>Esch. coli</i> (O <sub>111</sub> B <sub>4</sub> )	9	8	0
<i>Sh. flexneri</i> type 6	10	10	2
<i>Salm. cholerae-suis</i>	9	7	3
Nil	5	4	0

Living bacterial counts :

Immunizing doses

*Salm. paratyphi A* 107%

*Salm. cholerae-suis* 54%

*Sh. flexneri* type 6 101%

*Esch. coli* 92%

Challenge dose

*Salm. paratyphi C* 66%

Mouse strain :

Webster (male)

Similarly, dead heterologous bacilli also induce early resistance when given intraperitoneally. Table VI shows that 48 hours after immunizing with  $200 \times 10^6$  killed cells of various strains, mice could withstand an i.p. dose of  $80 \times 10^6$  living Ty2. Again, the heterologous organisms were slightly less effective than the same strain. When the challenge was delayed for 10 days only those mice immunized with the same *Salm. typhi* were fully protected, whereas those previously injected with *Salm. paratyphi A* and *Sh. flexneri* type 6 were normally susceptible. Paradoxically, 4 out of 10 animals survived this challenge ten days after receiving killed *Esch. coli*.

TABLE VIII.—THE EFFECT OF THE INTRAPERITONEAL INOCULATION OF VARIOUS KILLED ENTEROBACTERIACEÆ ( $200 \times 10^6$  BACILLI) 48 HOUR BEFORE THE INTRAPERITONEAL ADMINISTRATION OF  $200 \times 10^6$  LIVE *Salm. paratyphi C* (KEA)

Immunizing organism (Dose $200 \times 10^6$ killed bacilli)	Number of survivors after various periods following the administration of $200 \times 10^6$ <i>Salm. paratyphi C</i> (KEA) intraperitoneally. Ten animals inoculated in each group.	
	48 hours	6 days
<i>Salm. paratyphi A</i> (HA6)	9	2
<i>Esch. coli</i> (O <sub>111</sub> B <sub>4</sub> )	10	0
<i>Sh. flexneri</i> type 6	9	2
<i>Salm. cholerae-suis</i>	10	4
<i>Salm. paratyphi C</i> (KEA)	10	2
Nil	2	0

Living bacterial count of challenge dose of *Salm. paratyphi C* : 58%

Mouse strain :

Strong A (female)

### *The Comparative Protection obtained against Salm. typhi and Salm. paratyphi C Infections.*

The effect of this non-specific immunity phenomenon on a *Salm. paratyphi C* challenge is modified by the fact that this organism, even in small numbers, can multiply freely in the body of a mouse to produce true infective disease with a fatal termination. Table VII shows that the subcutaneous injection of live heterologous Gram-negative bacilli can protect against the immediate toxic effect of  $200 \times 10^6$  living cells of *Salm. paratyphi C* given 48 hours later. After only 4 days, however, most of the animals had succumbed to the challenge, whereas with *Salm. typhi* deaths are uncommon later than 2 days after inoculation of this order. Similar findings were obtained when the protective dose consisted of killed bacilli given intraperitoneally, again 48 hours before an i.p. challenge of  $200 \times 10^6$  *Salm. paratyphi C* (Table VIII). The protection afforded by these various dead Enterobacteriaceæ was slightly more durable than with the same dosages given live and subcutaneously, but by 6 days the majority of mice were also dead. There is little to choose between the degree of resistance after immunization with either *Salm. paratyphi C* itself or the antigenically related *Salm. cholerae-suis* and that following the unrelated *Salm. paratyphi A*, *Esch. coli* and *Sh. flexneri* Type 6.

### DISCUSSION

Similar examples of a rapid and transient increase in resistance to experimental infection have been reported previously in the literature. It appears definitely that more than one mechanism may be responsible for these phenomena. For example, Teague and McWilliams recorded in 1917 that the intravenous injection into rabbits of  $100 \times 10^6$  dead typhoid bacilli produced within 24 hours a refractory state which enabled them to withstand a dose of living

*Salm. typhi* fatal to normal animals. This phenomenon remained unexplained, but would appear to be related to our own results. Among the possible interpretations are that immunization induces rapidly either a state of increased tolerance of the endotoxin of typhoid bacilli or an enhancement of the normal bactericidal mechanisms of the animal. With regard to the former view, Hill, Hatswell and Topley (1940) were able to obtain mice, by selective breeding, which were more resistant to the endotoxin of *Salm. typhi-murium* than the original animals. It would be necessary, however, to postulate a much greater degree of tolerance, rapidly attained, to account for our own findings.

In support of the second interpretation is the observation of Wright (1927) that within 5 hours of the injection of killed pneumococci, live bacteria of the same strain were removed from the blood-stream of rabbits far more rapidly than in control animals. He considered this to be a specific mechanism, yet not associated with antibody formation, for similar immunization with killed *Salm. typhi* was without effect on the rate of pneumococcal clearance. (In this latter case, however, the immunizing dose of *Salm. typhi* was so large as to be markedly toxic to all animals and, in fact, sometimes fatal.) It is also well established that there is an increase in the bactericidal power of the blood from patients during the acute phase of several infectious diseases (Tillett, 1937).

There has been a recent intensification of interest in such types of immunity which clearly precede the production of antibodies. Evans and Perkins (1954a) have found that 5 hours after the intraperitoneal injection of pertussis vaccine, mice developed an immunity to intracerebral challenge with *Hæmophilus pertussis* unassociated with detectable antibody formation. This effect was specific, not being produced by other varied antigens. Mice were also protected when the vaccine was administered intracerebrally simultaneously with the challenge dose of *H. pertussis* (Evans and Perkins, 1954b). This species-specific immunity is considered by these workers to depend on an "interference phenomenon"—analogous to that known to occur in some virus diseases—and is obviously distinct from the mechanism operative in the present experiments.

An extensive review of the literature has been prepared by Brandis (1954), together with some original work to which our own is both complementary and clearly related. Brandis found that he could protect mice against a lethal dose of *Salm. derby* ( $300 \times 10^6$ ) by injecting  $2 \times 10^6$  homologous bacilli, either subcutaneously or intraperitoneally, only 24 hours previously. Equally good results were obtained with a similar immunizing dose ( $5 \times 10^6$ ) of *Salm. reading*. At this dosage level, however, the degree of immunity against *Salm. derby* was much less following the injection of *Salm. thomson*, *Salm. tennessee*, *Salm. virchow* or *Salm. stanley*. Nevertheless, such varied stimuli as T.A.B. and cholera vaccines, streptococci, *Esch. coli*, coli endotoxin, milk and peptone produced this rapid protective effect, which the author calls "pro-immunity." He considers that it is attributable to a rapid stimulation of the cellular defence mechanism of the body.

Although Brandis obtained rapid immunity following subcutaneous immunization with *Salm. derby*, he did not mention the use of this route for the administration of such non-specific substances as milk and peptone. It is known



that the intraperitoneal injection of such materials may provoke a localized leucocytic response which may increase the resistance of animals to subsequent bacterial challenge by the same route. Thus, Gay and Morrison (1923) found that the intraperitoneal injection of some substances, such as broth, protected rabbits against a streptococcal challenge 24 hours later, whereas others (including aleuronat) did not. The substances which enhanced immunity were associated with an exudate rich in macrophages, whereas the others produced an exudate which was predominantly polymorphonuclear. It is desirable to give the immunizing and challenge doses by differing routes to avoid effects due to these local changes.

Brandis also found that "pro-immunity" did not protect against *Salm. typhi-murium* and *Salm. enteritidis* when they were given in sub-toxic doses (2,000 bacilli), *i.e.*, the mechanism is not effective against salmonellæ which can produce a true progressive experimental infection. This agrees with our own finding that although rapid protection can be obtained against the toxic effect of large doses of *Salm. paratyphi C* the animals ultimately die, presumably from a progressive infection with this organism. The explanation possibly lies in the fact that the rapidly acquired resistance begins to fade after 4 days, long before one could expect a true infection with either *Salm. typhi-murium* or *Salm. paratyphi C* to be overcome.

Finally, Rowley (1955) found that the resistance of mice to infection with *Esch. coli* suspended in mucin was markedly increased 24-28 hours after administering a preparation of *Esch. coli* cell walls, although after only 2 hours the animals were more susceptible. This effect lasted a few days only, but was also obtained using the cell walls of antigenically unrelated strains of *Esch. coli* and of *Salm. typhi-murium*. Rowley (personal communication) considers that the somatic antigen is the active material in these cell wall extracts. In this experimental infection the cellular defences are inhibited by mucin, and Rowley has clearly correlated the resistance with changes in the bactericidal power of serum. He reports that after injecting his *Esch. coli* cell walls into mice, the serum level of properdin (Pillemer *et al.*, 1954)—a globulin fraction possessing a bactericidal action in the presence of complement—drops to 20 per cent. of the normal value, is rapidly restored and after 48 hours, may reach four times the original level. (Pillemer, personal communication, quoted by Rowley, 1955).

Rowley (personal communication) suggested that our results were likely to be due to the same mechanism. We have, accordingly, tested the effect of giving his *Esch. coli* cell wall preparation intravenously on a subsequent *Salm. typhi* challenge in mice. Table IX shows the results obtained with this substance, in addition to live and killed *Salm. typhi* and *Esch. coli* and a highly purified somatic antigen (*Sh. dysenteriae* type 1). All these agents were given intravenously 24 hours before an intraperitoneal challenge of typhoid bacilli, and, with the exception of the dead *Esch. coli*, appear to be equally protective. From the effectiveness of 10 $\mu$ g. of shiga somatic antigen, it is tempting to suggest that polymolecular complexes of this type play a dominant part in the development

TABLE IX.—THE PROTECTIVE EFFECT OF THE INTRAVENOUS INJECTION OF VARIOUS AGENTS 24 HOURS BEFORE THE ADMINISTRATION OF  $100 \times 10^6$  *Salm. typhi* strain Ty2 INTRAPERITONEALLY

Immunizing agent (Intravenous)	Number of survivors. Ten animals inoculated in each group.	
	Challenged with $100 \times 10^6$ <i>Salm. typhi</i> (Ty2) intraperitoneally	Unchallenged controls
Live <i>Salm. typhi</i> (Ty2) $50 \times 10^6$	9	9
Killed <i>Salm. typhi</i> (Ty2) $200 \times 10^6$	9	10
Live <i>Esch. coli</i> (O <sub>111</sub> B <sub>4</sub> ) $50 \times 10^6$	9	10
Killed <i>Esch. coli</i> (O <sub>111</sub> B <sub>4</sub> ) $200 \times 10^6$	3	10
<i>Esch. coli</i> (CV) cell wall 0.1 mg.	8	10
<i>Sh. dysenteriae</i> type 1, 0 antigen 10 $\mu$ g.	10	10
Nil	0	—

*Living bacterial counts :*Immunizing *Salm. typhi* dose : 70%Immunizing *Esch. coli* dose : 85%Challenge *Salm. typhi* dose : 86%*Mouse strain :*

Webster (female)

of this non-specific resistance to bacterial infection. Further work is in progress to establish more definitely the relationship of this bactericidal mechanism to our findings.

## SUMMARY

When mice were immunized subcutaneously with a sub-lethal dose of live *Salm. typhi* they began to show resistance after 4 hours to a fatal intraperitoneal challenge with the same organism. This phenomenon was well developed by 12 hours and continued undiminished into the stage of antibody immunity on the fourth to fifth day. Similarly, resistance against *Salm. typhi* was obtained by the subcutaneous injection of various other live Gram-negative bacilli being maximal over the period 24-48 hours; in this case, however, susceptibility to infection began to return on the third to fifth day and was again normal by the eighth day. The same precocious immunity followed the intraperitoneal, but not subcutaneous, injection of similar dosages of several killed Enterobacteriaceæ. The intravenous inoculation route was also used successfully, for not only did non-specific resistance follow the injection of live and dead bacteria, but also both an *Esch. coli* cell wall preparation and a purified "O" antigen from *Sh. dysenteriae* type 1.

This rapidly obtained immunity also protected mice against the immediate toxic effect of large doses of *Salm. paratyphi* C, but unlike animals challenged with *Salm. typhi* they succumbed several days later. This distinction is considered to be related to the very high infectivity of *Salm. paratyphi* C for mice.

The possible mechanism of this phenomenon is discussed.

## ACKNOWLEDGMENTS

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# PORTON LOW-PRESSURE AEROSOL DISPENSER

## REPORT ON A SERIES OF EXPERIMENTS TO CONFIRM THE EFFICIENCY OF THE DISPENSER AGAINST DIFFERENT TEST INSECTS

BY

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### AIM

THIS experiment was devised for the dual purpose of checking the efficiency of the dispenser and length of exposure time necessary to ensure complete kill of test insects ; and also for the training of laboratory staff in the method of conducting a scientific experiment.

### METHOD

A room was selected for the experiment in the Instructional Wing of the Army School of Health, and the volume for treatment was approximately 1,250 cu. ft. The door and windows were firmly closed during the test. The dosage on the directions given with the dispenser was 8 seconds per 1,000 cu. ft. and a dose of 10 seconds was therefore given in each test of the series. The contact times were 10, 5 and 2½ minutes with the three test insects used—*Anopheles stephensi*, *Aedes ægypti* and *Musca domestica*—making nine tests in all.

Test insects of selected stages of development and reared from laboratory culture were exposed in 4-inch cube cages, wire frames covered with mosquito netting. In each test, eight cages were exposed while two control cages were subjected to similar treatment except that they remained outside the test room in comparable atmospheric conditions. Cages were numbered, and placed at different levels in the test room, several in sheltered situations where insects might be expected to rest (see photographs). In each test, the numbers refer to the same situations, so that any failure of the aerosol to penetrate to certain parts of the room might be correlated in the series. Cages were sited in the test room as follows :

1. On top shelf, 6 ft. 6 in. from floor.
2. On second shelf, 5 ft. 6 in. from floor.
3. On open shelf, 4 ft. from floor, sheltered.
4. Under flap, 2 ft. from floor, sheltered.
5. On floor under bench, sheltered.
6. In fume cupboard, 2 ft. from floor with sliding door almost closed.
7. On floor under fume cupboard.
8. On second shelf, 5 ft. 6 in. from floor.
9. } Control cages.
10. }

## SUMMARY

Ground level	...	...	...	...	...	Three cages
2 ft. from floor	...	...	...	...	...	Two cages
Over 5 ft. from floor	...	...	...	...	...	Three cages

Knockdowns were recorded in each cage before the experiment began, immediately after contact time, and then at intervals over the ensuing 24 hours. Similar records were taken of results in the control cages.

## RESULTS

The results are recorded in Appendix I. In computing mortalities in each test, the formula of Abbott (1925) was applied in order to standardize for knockdown in control cages. This formula gives corrected knockdown as :

$$\frac{(x-y)}{x} \times 100. \quad \text{Where } x = \text{percentage survival in untreated cages.}$$

$$y = \text{percentage survival in treated cages.}$$

## Appendix I.

## EXPERIMENT No. 1

Test insect : *Anopheles stephensi*, 3-day-old, blood-fed, females.

Room volume : 1,250 cu. ft.

Exposure time : 10 seconds.

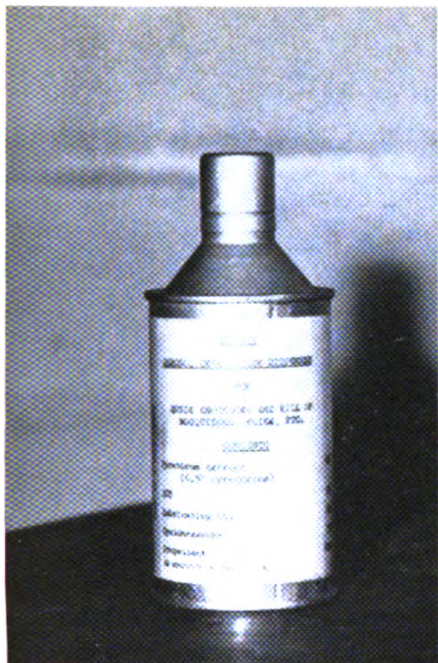
Contact time : 10 minutes.

	Test Insects								Controls	
Cage number	1	2	3	4	5	6	7	8	9	10
Number of insects per cage	10	10	10	10	10	10	10	10	10	10
Knockdown before test	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil
Knockdown after contact period	4	1	2	3	4	0	1	3	Nil	Nil
Knockdown after										
½ hour	10	10	10	10	10	10	10	10	Nil	Nil
1 hour	10	10	10	10	10	10	10	10	Nil	Nil
2 hours	10	10	10	10	10	10	10	10	Nil	Nil
4 hours	10	10	10	10	10	10	10	10	Nil	Nil
6 hours	10	10	10	10	10	10	10	10	Nil	Nil
24 hours	10	10	10	10	10	10	10	10	1	1

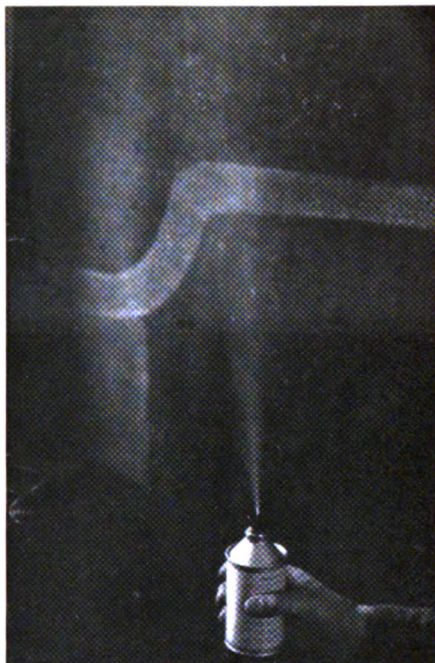
## RESULTS (Abbott's formula applied)

Mortality after contact	22.5%
½ hour	100%
1 hour	100%
2 hours	100%

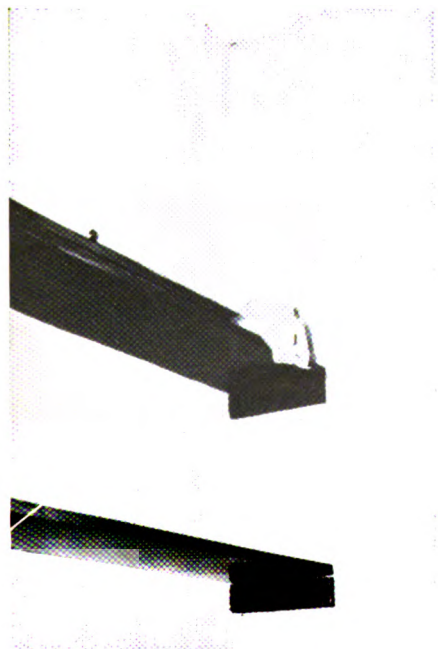
Mortality after 4 hours	100%
6 hours	100%
24 hours	100%



## THE PORTON LOW-PRESSURE AEROSOL DISPENSER



## THE DISPENSER IN USE

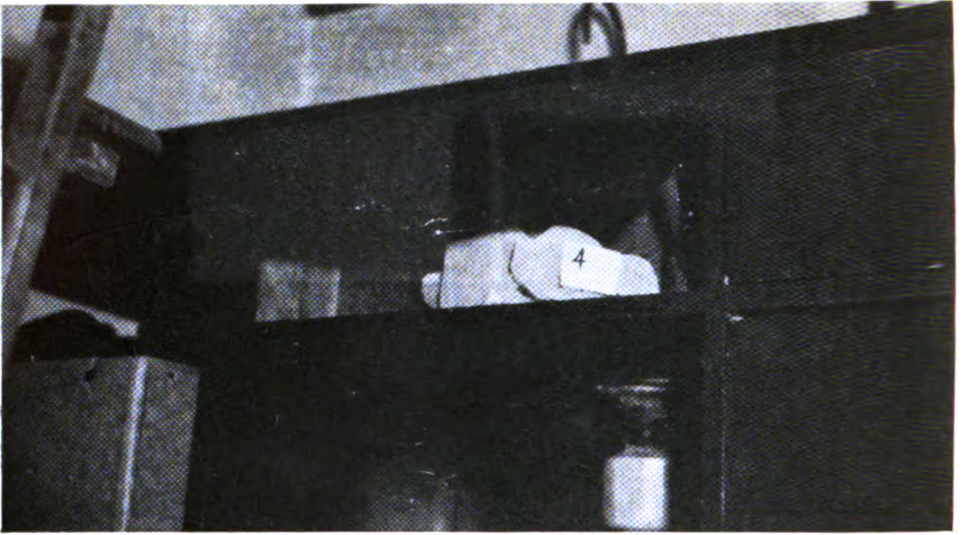


### CAGE 1

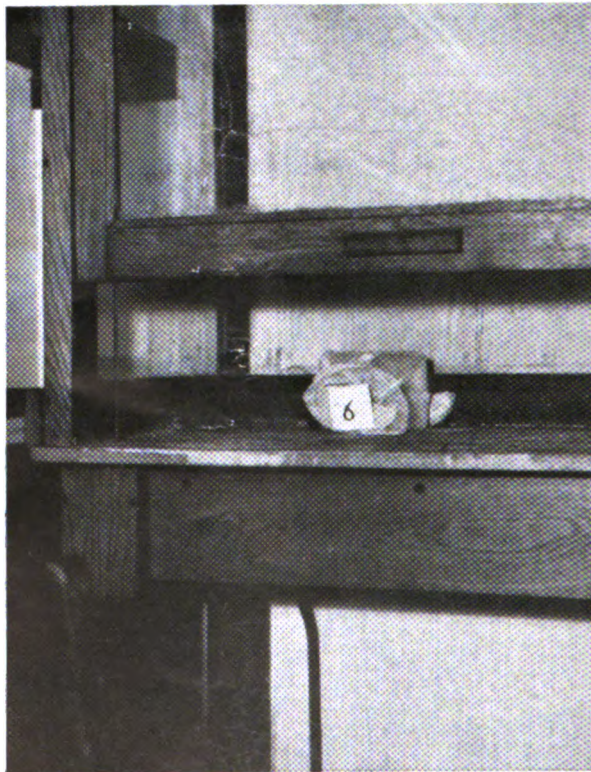


### CAGE 5





CAGE 4



CAGE 6

## EXPERIMENT No. 2

Test insect : *Anopheles stephensi*, 3-day-old, blood-fed, females.

Room volume : 1,250 cu. ft.

Exposure time : 10 seconds.

Contact time : 5 minutes.

	Test Insects								Controls	
Cage number	1	2	3	4	5	6	7	8	9	10
Number of insects per cage	10	10	10	10	10	10	10	10	10	10
Knockdown before test	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil
Knockdown after contact period	Nil	Nil	Nil	1	Nil	1	1	Nil	Nil	Nil
Knockdown after $\frac{1}{2}$ hour	10	10	10	10	10	10	10	10	Nil	Nil
1 hour	10	10	10	10	10	10	10	10	Nil	Nil
2 hours	10	10	10	10	10	10	10	10	Nil	Nil
4 hours	10	10	10	10	10	10	10	10	Nil	Nil
6 hours	10	10	10	10	10	10	10	10	1	1
24 hours	10	10	10	10	10	10	10	10	9	8

## RESULTS (Abbott's formula applied)

Mortality after contact	3.8%	Mortality after 4 hours	100%
$\frac{1}{2}$ hour	98.7%	6 hours	100%
1 hour	100%	24 hours	100%
2 hours	100%		

(Control mortality high due to excessive movement in carriage to test room.)

## EXPERIMENT No. 3

Test insect : *Anopheles stephensi*, 3-day-old, blood-fed, females.

Room volume : 1,250 cu. ft.

Exposure time : 10 seconds.

Contact time :  $2\frac{1}{2}$  minutes.

	Test Insects								Controls	
Cage number	1	2	3	4	5	6	7	8	9	10
Number of insects per cage	8	8	8	8	8	8	8	8	8	8
Knockdown before test	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil
Knockdown after contact period	Nil	1	1	1	Nil	1	2	1	Nil	Nil
Knockdown after $\frac{1}{2}$ hour	8	8	4	4	5	8	8	8	Nil	Nil
1 hour	8	8	8	4	6	8	8	8	Nil	Nil
2 hours	8	8	8	7	7	8	8	8	Nil	Nil
4 hours	8	8	8	7	8	8	8	8	Nil	Nil
6 hours	8	8	8	7	8	8	8	8	Nil	Nil
24 hours	8	8	8	7	7	8	8	7	Nil	3

## RESULTS (Abbott's formula applied).

Mortality after contact	10.9%	Mortality after 4 hours	98.5%
$\frac{1}{2}$ hour	82.8%	6 hours	98.5%
1 hour	90.6%	24 hours	94.2%
2 hours	96.9%		



## EXPERIMENT No. 4

Test insect : *Aedes ægypti*, 2-3-day-old, blood-fed, females.

Room volume : 1,250 cu. ft.

Exposure time : 10 seconds.

Contact time : 10 minutes.

	Test Insects								Controls	
Cage number	1	2	3	4	5	6	7	8	9	10
Number of insects per cage	10	10	10	10	10	10	10	10	10	10
Knockdown before test	1	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil
Knockdown after contact period	2	5	1	1	1	2	6	2	Nil	Nil
Knockdown after										
½ hour	10	10	10	10	10	10	10	10	Nil	Nil
1 hour	10	10	10	10	10	10	10	10	Nil	Nil
2 hours	10	10	10	10	10	10	10	10	Nil	Nil
4 hours	10	10	10	10	10	10	10	10	Nil	Nil
6 hours	10	10	10	10	10	10	10	10	Nil	Nil
24 hours	10	10	10	10	10	10	10	10	1	4

RESULTS (Abbott's formula applied).

Mortality after contact 25.3%

½ hour 100%

1 hour 100%

2 hours 100%

Mortality after 4 hours 100%

6 hours 100%

24 hours 100%

## EXPERIMENT No. 5

Test insects : *Aedes ægypti*, 4-day-old, blood-fed, females.

Room volume : 1,250 cu. ft.

Exposure time : 10 seconds.

Contact time : 5 minutes.

	Test Insects								Controls	
Cage number	1	2	3	4	5	6	7	8	9	10
Number of insects per cage	10	10	10	10	10	10	10	10	10	10
Knockdown before test	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil
Knockdown after contact period	3	2	Nil	3	1	1	4	1	Nil	Nil
Knockdown after										
½ hour	10	8	10	10	8	9	9	10	Nil	Nil
1 hour	10	10	10	10	10	10	10	10	Nil	Nil
2 hours	10	10	10	10	10	10	10	10	Nil	Nil
4 hours	10	10	10	10	10	10	10	10	Nil	Nil
6 hours	10	10	10	10	10	10	10	10	Nil	Nil
24 hours	10	10	10	10	10	10	10	10	3	Nil

RESULTS (Abbott's formula applied).

Mortality after contact 18.8%

½ hour 92.5%

1 hour 100%

2 hours 100%

Mortality after 4 hours 100%

6 hours 100%

24 hours 100%

## EXPERIMENT No. 6

Test insect : *Aedes ægypti*, 3-day-old, blood-fed, females.

Room volume : 1,250 cu. ft.

Exposure time : 10 seconds.

Contact time : 2½ minutes.

	Test Insects								Controls	
Cage number	1	2	3	4	5	6	7	8	9	10
Number of insects per cage	10	10	10	10	10	10	10	10	10	10
Knockdown before test	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil
Knockdown after contact period	2	1	Nil	4	2	Nil	3	Nil	Nil	Nil
Knockdown after ½ hour	9	8	10	10	8	6	7	10	Nil	Nil
1 hour	10	8	10	10	8	10	8	10	Nil	Nil
2 hours	10	9	10	10	9	10	8	10	Nil	Nil
4 hours	10	9	10	10	9	10	8	10	Nil	Nil
6 hours	10	9	10	10	9	9	8	10	Nil	Nil
24 hours	10	8	10	10	9	9	9	10	2	Nil

## RESULTS (Abbott's formula applied).

Mortality after contact	15.0%	Mortality after 4 hours	95.0%
½ hour	85.0%	6 hours	93.7%
1 hour	92.5%	24 hours	93.1%
2 hours	95.0%		

## EXPERIMENT No. 7

Test insect : *Musca domestica*, 4-day-old, fed laboratory culture.

Room volume : 1,250 cu. ft.

Exposure time : 10 seconds.

Contact time : 10 minutes.

	Test Insects								Controls	
Cage number	1	2	3	4	5	6	7	8	9	10
Number of insects per cage	10	10	10	10	10	10	10	10	10	10
Knockdown before test	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil
Knockdown after contact period	3	5	5	7	2	3	1	7	Nil	Nil
Knockdown after ½ hour	10	10	10	10	10	10	10	10	Nil	Nil
1 hour	10	10	10	10	10	10	10	10	Nil	Nil
2 hours	10	10	10	10	10	10	10	10	Nil	Nil
4 hours	10	10	10	10	10	10	10	10	Nil	Nil
6 hours	10	10	10	10	10	10	10	10	Nil	Nil
24 hours	10	10	10	10	10	10	10	10	Nil	Nil

## RESULTS (Abbott's formula applied).

Mortality after contact	41.3%	Mortality after 4 hours	100%
½ hour	100%	6 hours	100%
1 hour	100%	24 hours	100%
2 hours	100%		

## EXPERIMENT No. 8

Test insect : *Musca domestica*, 4-5 day-old, fed laboratory culture.

Room volume : 1,250 cu. ft.

Exposure time : 10 seconds.

Contact time : 5 minutes.

	Test Insects								Controls	
Cage number	1	2	3	4	5	6	7	8	9	10
Number of insects per cage	10	10	10	10	10	10	10	10	10	10
Knockdown before test	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil
Knockdown after contact period	3	Nil	5	4	1	1	2	5	Nil	Nil
Knockdown after										
$\frac{1}{2}$ hour	8	8	7	10	9	7	5	10	Nil	Nil
1 hour	10	10	10	10	10	10	10	10	Nil	Nil
2 hours	10	10	10	10	10	10	10	10	Nil	Nil
4 hours	10	10	10	10	10	10	10	10	Nil	Nil
6 hours	10	10	10	10	10	10	10	10	Nil	Nil
24 hours	10	10	10	10	10	10	10	10	1	Nil

## RESULTS (Abbott's formula applied).

Mortality after contact	26.3%	Mortality after 4 hours	100%
$\frac{1}{2}$ hour	80.0%	6 hours	100%
1 hour	100%	24 hours	100%
2 hours	100%		

## EXPERIMENT No. 9

Test insect : *Musca domestica*, 3-4-day-old, fed laboratory culture.

Room volume : 1,250 cu. ft.

Exposure time : 10 seconds.

Contact time : 2 $\frac{1}{2}$  minutes.

	Test Insects								Controls	
Cage number	1	2	3	4	5	6	7	8	9	10
Number of insects per cage	10	10	10	10	10	10	10	10	10	10
Knockdown before test	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil
Knockdown after contact period	Nil	Nil	1	2	Nil	1	Nil	Nil	Nil	Nil
Knockdown after										
$\frac{1}{2}$ hour	Nil	Nil	1	Nil	Nil	Nil	Nil	Nil	Nil	Nil
1 hour	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil
2 hours	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil
4 hours	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil
6 hours	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil
24 hours	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil

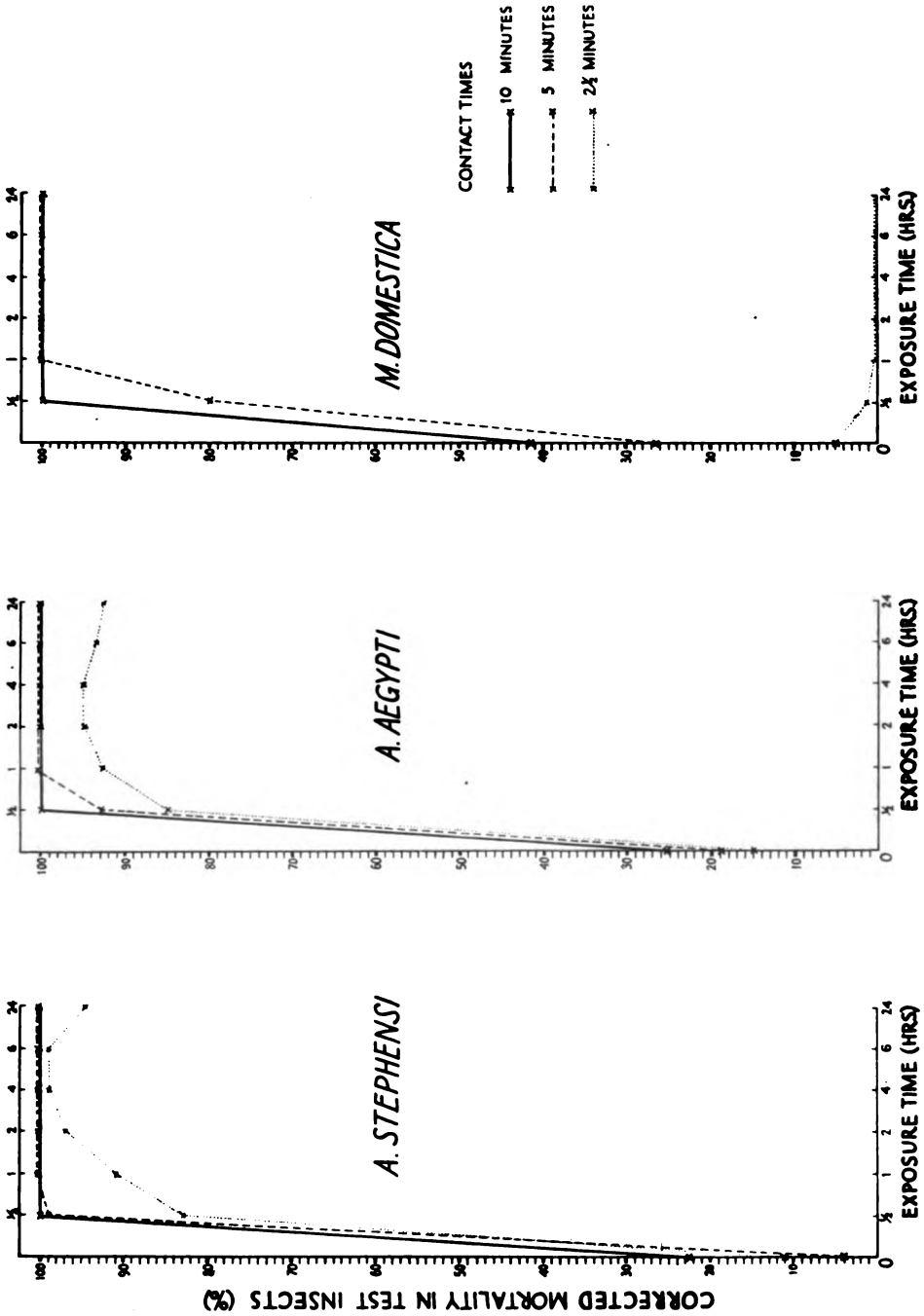
## RESULTS (Abbott's formula applied).

Mortality after contact	5.0%	4 hours	Nil
$\frac{1}{2}$ hour	1.3%	6 hours	Nil
1 hour	Nil	24 hours	Nil
2 hours	Nil		

(Universal recovery from exposure).

The results are further shown graphically in Appendix II.

APPENDIX II.



## CONCLUSIONS

Results show that, after 5 minutes' contact time at recommended dosage of 8 seconds per 1,000 cu. ft., 100 per cent. knockdown was obtained after  $\frac{1}{2}$ —1 hour with no recovery. After  $2\frac{1}{2}$  minutes' contact, however, recovery occurred in a proportion of the mosquitoes tested and in all the houseflies.

A contact time of 5 minutes is considered to be a safe recommendation, especially as the insects in small cages were protected from the larger sizes of particle by the cotton mesh. When in flight in the room, these insects accumulate dosages of the insecticide in proportion to their speed of flight and the distance flown (David & Bracey, 1946) and both these factors were very limited in 4-inch cube cages.

It is recommended that doors and windows should be kept closed for at least five minutes after exposure at the prescribed dosage. The importance of sealing the room during treatment is emphasized as air movement limits the effect of the aerosol.

It should be noted on the instructions that knockdown is not necessarily immediate, but that death occurs in insects in all cases after  $\frac{1}{2}$ —1 hour. This will tend to prevent uneconomical overdosage in an attempt to produce 100 per cent. kill.

## REFERENCES

- ABBOTT, J. (1925), *J. Econ. Ent.*, **18**, 265.  
DAVID, W. A. L. AND BRACEY, P. (1946), *Bull. Ent. Res.*, **37**, 177-190.

# SUGGESTIONS FOR THE REVISION OF THE REGIMENTAL MEDICAL PANNIER

BY

**Captain N. E. SHAW**

*Royal Army Medical Corps*

## INTRODUCTION

THE serviceability of the present Regimental Medical Pannier has recently been discussed. Likewise the contents of the pannier have been criticized. On detailed examination of the pannier and comparison with that of the American Armies it is apparent that the latter is easier to use in the field. Moreover, the drugs in the present R.M.P. have gradually become outmoded by their modern substitutes.

In view of these criticisms a careful study of the design of the pannier and also a survey of the equipment contained in it is required to elevate the quality of the pannier to even greater standards than that of our Allies.

## CRITICISM OF PRESENT DESIGN

The pannier in current use is divided into only two main compartments without any further subdivision except for the metal containers. This lack of subdivisions prevents orderly storage of the contents, and if the contents are to be arranged in order in the field they must be removed from the pannier and placed on a table. Furthermore, when the R.A.P. changes location the equipment must be repacked. Both of these operations are time consuming, and in modifications of the pannier an effort must be made to reduce the time of repacking to a minimum. A complete redesign of the pannier is needed to obviate removal of equipment from the box as far as possible. It is also fair to assume that a new pannier should have compartments to enable the user to identify articles by touch, and that items will always be kept in the same compartment. Its use could then be likened to the sterile theatre trolley, where every item has a particular place.

In addition to these criticisms, carriage of the pannier is difficult. It is heavy and requires at least two bearers for hand carriage, and even that is not practicable over long distances. In modern theatres of war such as jungle and mountain terrains, forward points are inaccessible by jeep and hand carriage is necessary. It is suggested that a light pannier which could be carried by one man is required.

After frequent unpacking and repacking, particles of dirt such as herbage and soil inevitably gain access to the pannier. This can be prevented by using a pannier which requires no reassembly of its contents.

## CRITICISMS OF THE CONTENTS OF THE REGIMENTAL MEDICAL PANNIER

Criticism is based on the belief that treatment at the regimental aid post must be confined to essential first aid measures only.

Many of the contents of the pannier—*e.g.*, iodine and sulphathiazole—are obsolete, and require replacing by modern items. There are several important contingencies and modern war injuries such as phosphorous burns which are not catered for.

Lysol has recently been replaced by mercuric iodide as an antiseptic, but it is questionable whether an antiseptic of this nature is required at this level. Cetavlon is now accepted as the ideal antiseptic and detergent. Cetyl trimethyl ammonium bromide in tablet or capsule form suitable for preparation of antiseptic solutions in the field would answer the problem.

Ointment is present in the pannier only as Brulidine. This ointment is stored in tubes, a wise practice exhibiting cleanliness and convenience of packing. It may well be the only antiseptic ointment required, because it is claimed that Brulidine is bacteriostatic to a wide range of Gram-positive organisms and effective against certain pathogenic fungi. Copper sulphate 4 per cent. in soft soap for treatment of phosphorous burns must also be supplied in tubes.

Catgut is now supplemented by nylon as a suture material in the surgical hold-all. Nylon is supplied in paper packets, which is not acceptable at this level, and should be provided as sterile suture material in a sealed vial.

The syringes in use are glass syringes. Cartridge syringes could be used to replace these and the cartridge retained sterile by the use of spirit. If in fact glass syringes are to be used, it would be better to store them in spirit cases with three needles ready for use. Two of these instruments could be contained in the pannier to great advantage. Ampoules for injection are included in the current equipment. Although it is not possible to store all injections in cartridges for use in cartridge syringes, the speed of using such a syringe and the ease of storage are undeniable. Provision of drugs in this form is worthy of consideration.

In addition to tetanus toxoid it is necessary to include anti-tetanus serum in the pannier. In the 1939-45 war it was customary to give wounded patients 3,000 international units of anti-tetanus serum. This supplemented active immunization and covered those who may have refused inoculation previously.

Transport of chloroform in hermetically sealed glass cylinders would be better replaced by a number of ampoules of chloroform as used in armoured fighting vehicle first aid boxes. Sufficient chloroform is contained in these for short term anæsthetics. Long anæsthetics with this drug in the field are inadvisable unless administered by a person experienced in its use. For long term anæsthetics it could be replaced by ethyl-chloride-ether, but it is difficult to foresee the requirement of any general anæsthetic except at A.D.S.—C.C.S. level.

One is still bound to regard liquid paraffin as one of the most suitable of the lubricant aperients, but there is no reason to believe that an aperient cannot be supplied in tubes as petrolagar. The system of tube storage reduces the carriage of liquid to a minimum.

Instruments of diagnosis require supplementing with a patella hammer, wooden tongue depressors and orange sticks. It is questionable whether catheters are necessary at a regimental aid post. Conditions are not all that could be

desired, and catheterization except under aseptic conditions is not a procedure to be undertaken.

Dressings, gauze, cotton-wool and bandages which are supplied in paper packets should be contained in cardboard cartons, because dressings in a torn paper packet are readily soiled after lying in the pannier for a short time.

Glass bottles for medicaments are heavy and perishable, whereas aluminium containers for tablets are lighter and unbreakable, and could well be included as non-expendable items.

The toilet soap and nail brush in the pannier are loose, and in a new pannier must be stored in soap tins if soiling of the other articles is to be prevented.

Fish-kettle sterilisers have proved adequate in the past, and are simple and easy to maintain in the field. The methylated spirit should be replaced by a solid fuel, *e.g.*, methaldehyde, to facilitate transport and further eliminate carriage of liquids. Until a sterilizer is designed which proves much superior to the present one for maintenance in the field it must be retained in the suggested pannier.

There are no divisions in the main body of the present pannier to allow for neatness, tidiness and ease of handling. Each one of these is a precursor of cleanliness. One finds all material neatly arranged when the pannier is opened, but one quick move in the field and it is anybody's guess where a particular item is situated in the pannier.

#### RECOMMENDATION FOR DESIGN OF A NEW REGIMENTAL MEDICAL PANNIER

Observations considered in designing a new regimental medical pannier necessitated the acceptance of certain fundamentals. The principle of the art is method. The suggestions offered are based on this fact. The foremost essentials implemented are that a new pannier must be substantially constructed and at the same time light in weight. Essentially, one must go a stage further and consider expense and ease of manufacture, which are no less important, and simplicity of design is vital to fulfil these requirements.

As an adjunct to these suggestions, standardization of containers and dressings and maintenance of clean equipment have been borne in mind.

#### CONSTRUCTION

The suggested pannier is of wooden construction with metal fittings. The outer walls are of  $\frac{1}{2}$ -inch five-ply wood and the inner compartments and subdivisions of  $\frac{3}{16}$ -inch three-ply wood. The pannier comprises a main body of the box with four minor compartments which are subdivided into many smaller compartments. The four main compartments are superimposed on the main body of the box, two at each end, one above the other. Each of these is attached to the body of the box and to its partner, either above or below, by metal brackets, so that each compartment lifts away from the one below it to avoid obscuring the contents of the lower one when the pannier is in use. The boxes of the compartments remain attached to one another by metal brackets throughout use.

The lid of the box is of  $\frac{1}{2}$ -inch five-ply wood and covers the whole length of the upper compartments as one sheet. The under surface of the lid is surrounded



by a  $\frac{1}{2}$ -inch wooden flange inset from the edge to form a seating on the upper compartments. It is finished on the undersurface with a heat-resistant material so that when inverted on the body of the box it may be used as a table for instruments.

When the box is closed the lid is retained in position by metal clips, and handles are provided at each end for transport. Protection of the corners of the box may be ensured by light metal angles set flush with the wood. One might even go a stage further and suggest that the main compartment of the pannier be detachable, so that each could be carried by the medical orderlies in jungle and mountain terrains, and the whole reconstituted on arrival at a new location.

The specifications of the box may be seen from the appended diagrams.

#### SUMMARY

The shortcomings of the old type regimental medical pannier are discussed. Observations and recommendations for the complete redesign are suggested, bearing in mind the following principles :

1. Ease and expense of manufacture.
2. Substantial but lightweight construction.
3. Simplicity of design.
4. Maintenance of clean equipment in an orderly manner.

A suggested design of the pannier is considered.

These features offer greater facility in the field and enable one to "set up shop" in a matter of seconds with everything available for use.

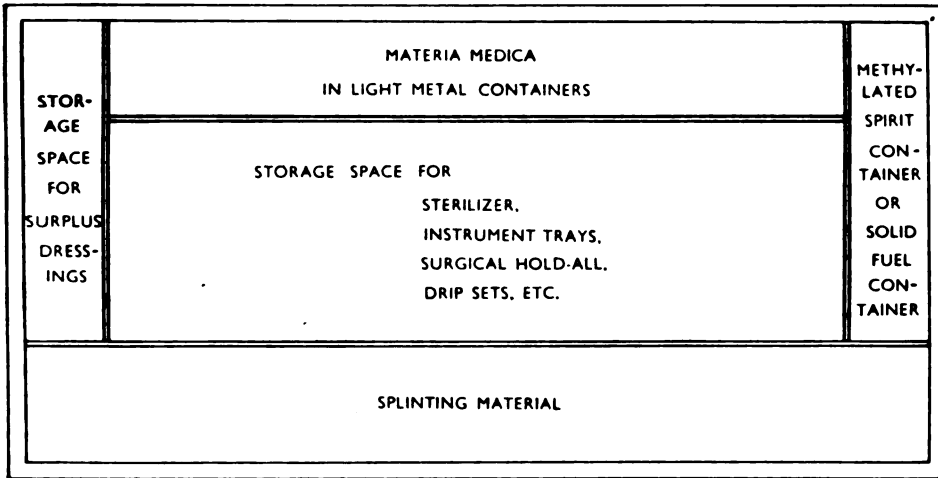
Diagrams of a suggested pannier are submitted at Appendix "A" and the detail of the complete regimental pannier in revised form at Appendix "B."

#### ACKNOWLEDGMENTS

I wish to offer my appreciation to the Commanding Officer and the Quartermaster of the 2nd Battalion Coldstream Guards and to Sgt. Stenning and my clerk, Herr Walter Lober, for their help in the preparation of this paper. I am also indebted to Colonel J. A. D. Johnston, Assistant Director of Medical Services, 2nd Infantry Division, for his helpful criticism and kindness.

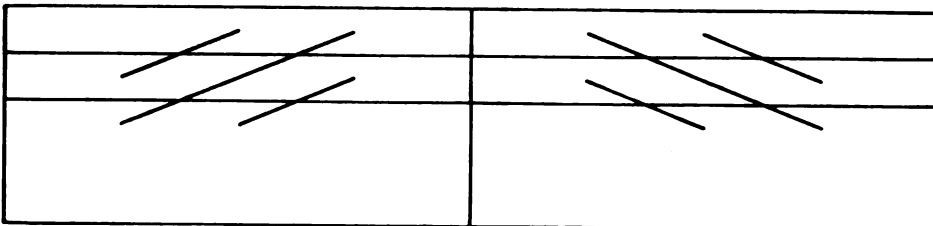
(The War Office states that this pannier is being considered by a committee, and that a large proportion of Captain Shaw's points are already included.—Ed.)

*Appendix "A"*



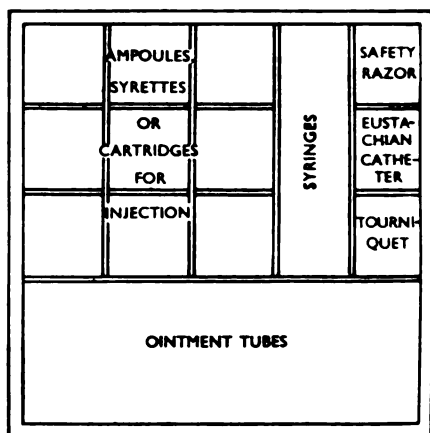
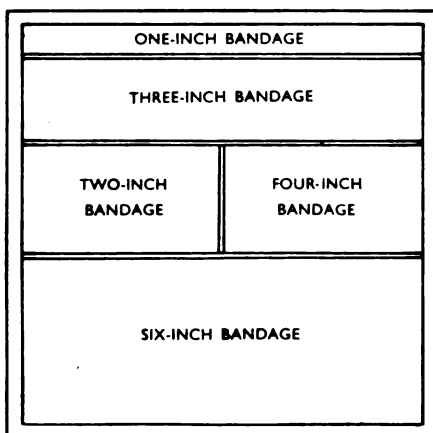
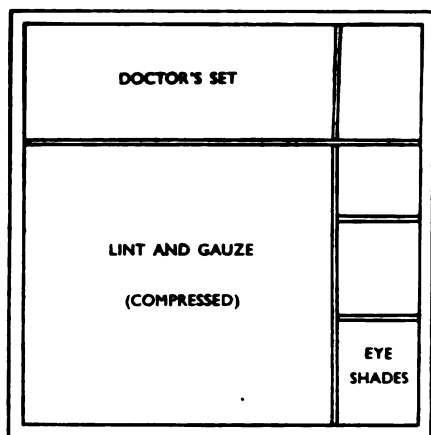
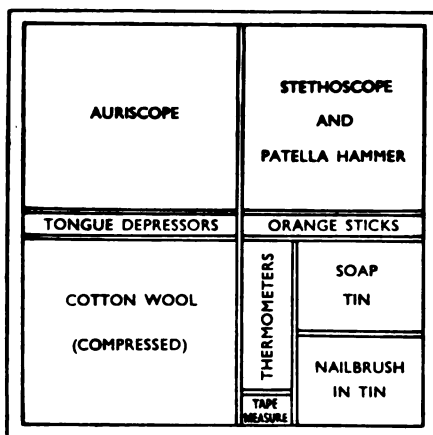
Scale in Inches:

A SUGGESTED ARRANGEMENT FOR THE MATERIALS IN THE MAIN COMPARTMENT



Scale in Inches

SIDE ELEVATION OF THE ASSEMBLED PANNIER



Scale in Inches:

## Appendix "B"

Catalogue or Part No.	Designation	Quantity
1	2	3

<i>Section H1 (B)</i>								
H1/HA 12667	METHYLATED SPIRIT OR METHALDEHYDE	.						
H1/HA 12902	Industrial grade 2 SOAP, toilet	... ..	...	...	...	...	gallon tablets	18 2
<i>Section KC</i>								
KC 4473	SCISSORS, stretcher-bearer	... ..	...	...	...	...	pair	1

Catalogue or Part No.	Designation	Quantity
1	2	3
<i>Section CC</i>		
CC 0556	RAZORS, safety ... ..	1
CC 1086	BLADES ... ..	2
<i>R.A.M.C. SUPPLY</i>		
<i>Section 1A</i>		
1A-01306	CREAM, di-bromopropamide isenthonate, 4-oz. tubes ... ..	2
	PARAFFIN	
	In tubes as petrolagar (to replace 1A-06700—liquid paraffin, B.P., 3/20 pint) ... ..	1
1A-06725	Yellow, soft, B.P., 4-oz. tubes ... ..	2
	INJECTION	
1A-03430	Morphine hydrochloride, $\frac{1}{2}$ -grain ampoules (to replace $\frac{1}{2}$ fl. oz. in 2-oz. rubber-capped amber bottles) ... ..	24
1A-03620	Nikethamide, B.P., 2-ml. ampoules ... ..	6
1A-03860	Phenobarbitone sodium, B.P., 220-mgm. ampoules, with solvent 1-ml. ampoules ... ..	18
	ADDITIONAL INJECTIONS—For inclusion in suggested pannier	
	Tetanus Toxoid in ampoules, 1-ml. ampoules ... ..	24
	Anti-Tetanus Serum, 1-c.c. ampoules ... ..	24
	Procaine Penicillin with solvent, 1-ml. ampoules (200,000 units per ml.) ... ..	20
	Paraldehyde, 2-c.c. ampoules ... ..	10
	Adrenalin 1/1,000 6 $\times$ 0.5-ml. ampoules ... ..	6
<i>Section 1B</i>		
	TABLETS (oral)	
1B-01270	Acetylsalicylic acid, B.P. ... ..	500
1B-02200	Ipecacuanha and Opium, B.P. ... ..	100
1B-02600	Phenobarbitone, B.P., 1-grain ... ..	500
1B-03040	Sulphaguanidine, B.P., 0.5-gram. ... ..	500
	ADDITIONAL TABLETS (oral)—for inclusion in suggested pannier	
	Sulphamezathine (Tab. Sulphadimidine) 0.5-gram. ... ..	500
	Sodium citrate, 2-grain ... ..	500
	Potassium permanganate (for mouth washes) ... ..	500
	Aludrox ... ..	500
	Anthisan, 100-mgm. ... ..	500
	Seconal (Quinalbarbitone 1 $\frac{1}{2}$ grains) ... ..	500
	SOLUTION TABLETS	
	Cetyl-trimethyl-ammonium bromide in tablet form, 1-gram tablets	200
<i>Section 2A</i>		
	BANDAGES	
2A-00830	Loose woven, open weave, B.P.C., khaki, compressed, 3-in. $\times$ 4-yd. To be supplemented in the suggested pannier by 1-in. $\times$ 4 yd. 2-in. $\times$ 4 yd. 4-in. $\times$ 4 yd. 6-in. $\times$ 4 yd.	30 30 30 14 30
2A-01320	Triangular, khaki, compressed, packets of 2 ... ..	10
2A-01840	DRESSINGS, elastic, adhesive, set in thin, complete ... ..	1
2A-02400	GAUZE, absorbent, B.P.C., compressed, 36-in. $\times$ 2 $\frac{1}{2}$ -yd. ... ..	24
2A-02850	JACONET, B.P.C., width 44-in. ... ..	2
2A-02910	LINT, absorbent, B.P.C., 4-oz. ... ..	4
	PLASTER, adhesive, zinc oxide, B.P.C.	
2A-03500	1-in. $\times$ 5-yd. in sealed tins ... ..	3
2A-03530	3-in. $\times$ 5-yd. in sealed tins ... ..	1
2A-04560	WOOL, cotton, absorbent, B.P.C., compressed 2-oz. ... ..	24

Catalogue or Part No.	Designation	Quantity
1	2	3
<i>Section 3A</i>		
3A-00600	AURISCOPE, electric, in case, complete To be supplemented in suggested pannier by tongue depressors, orange sticks and patella hammer	
3A-01810	CASES, hypodermic, 1942 pattern, complete (see A.F. G1098/1198/1198 (T.A.) Schedule 585) ... ..	1
3A-09100	INSTRUMENTS, regimental medical panniers, complete (see A.F. G1098/1198/1198 (T.A.) ... ..	set 1
3A-20090	NEEDLES, hypodermic, 1½-in. × 21 s.w.g. short level point, BSS fitting/Schedule No. 386) ... ..	6
3A-19790	SYRINGES, hypodermic BSS, 1263, all glass, 2-ml., with 4 needles, in spirit-tight case	
3A-20003	Glass, with metal nozzle and mount only, BSS, 1263 fitting, 5-ml., EN ... .. To be supplemented by additional syringe in spirit-tight case or replaced by cartridge syringes	1
<i>Section 4A</i>		
	BASINS, dressing, EI, K.S.	
4A-00760	8-in. ... ..	1
4A-00762	10-in. ... ..	1
4A-01064	BATTERIES, dry, ER, No. U. 10-cell ... ..	4
4A-02172	BRUSHES, nail, ward ... ..	1
4A-07435/45	PENCILS, dermatograph, blue or yellow ... ..	1
4A-07827	PINS, safety, straight, assorted, tins of 36 ... ..	tin 1
	SHADES, eye	
4A-08562	Double ... ..	4
4A-08572	Single ... ..	12
	SUTURES, nylon, sterile, B.P.C. medium thromic, 30-in.	
4A-10346	Size 1 ... ..	tubes 6
4A-10347	Size 2 ... ..	tubes 6
4A-11140	SYRINGES, I.R. adaptable ... ..	1
4A-11150	Catheter, eustachian ... ..	1
4A-11360	TAPES, measuring, linen, 5-ft. ... ..	1
4A-11495	THERMOMETERS, clinical, ½ minute, in case ... ..	2
4A-11860	TOURNIQUETS, Singer ... ..	1
4A-13413	TUBING, drainage, red rubber, 8/32-in. 1/16-in. wall ... ..	yard 1
<i>Section 4C</i>		
4C-01015	PLIERS, wire-cutting ... ..	pair 1
4C-01275	SPLINTING, wire, Cramer, 60-cm. × 8-cm. ... ..	10
<i>Section 7A</i>		
7A-02620	STERILIZERS, fish kettle, 10-in. × 4-in. × 2½-in., complete, pannier pattern ... ..	1
<i>H.M.S.O. SUPPLY</i>		
A.B. 39	PRESCRIPTION BOOK ... ..	1
F. Med. 26	CARDS, field medical ... ..	100
F. Med. 25	ENVELOPES ... ..	100
A.F.W.3211	SULPHONAMIDE LABELS ... ..	50
	PENCILS, lead ... ..	2

## PREGNANCY IN CHRONIC NEPHRITIS

BY

**Captain ALAN N. COWAN**

*Royal Army Medical Corps*

*Clinical Officer in Obstetrics, British Military Hospital, Tripoli*

THIS condition is met with sufficiently rarely in pregnant women to make the following case of some interest.

*Case Report.*—Mrs. R., aged 29, was referred by the medical officer at her husband's unit on 25.6.53. Her last menstrual period was on 15.5.53. She had had no previous pregnancy, but had been under investigation for high blood pressure a year before. A report on her case was received from the U.K. as follows :

"She has been known to have mild hypertension for at least two years. She was admitted to hospital on 23.7.52, the day she fainted whilst having an intravenous pyelogram done as an out-patient when this state was being investigated. She had no symptoms and her general health was good.

"Whilst in hospital her blood pressure varied from 130/90 to 165/105. Her urine on admission contained a fair number of hyaline casts and an occasional granular cast, with a trace of albumin. The casts disappeared from her urine, and it was occasionally albumin-free, although a faint haze could be detected from time to time. Blood urea on admission was 43 mgm. per cent., falling to 20 mgm. per cent on 11.9.52.

"She was discharged from hospital on 14.8.52, and I have observed her since as an out-patient. At first she continued to be on a low protein diet, which made her thin and underweight. She weighed 7 st. 0½ lb. on 11.9.52. Since this was abandoned she has gained weight and felt much better. She weighed 7 st. 10½ lb. on 9.1.53. Her blood pressure in September, 1952, was 160/100, 165/100 in October, 1952, and 180/100 in January, 1953. There was a haze of albumin in the urine.

"I feel pretty certain Mrs. R. has a mild chronic nephritis. She is so far childless and is very anxious to have a baby, and the question as to whether or not pregnancy should be advised is a difficult one. She would require close observation throughout. The risk is naturally a greater one than normal, and there is the possibility that such a pregnancy may require termination. However, I do not feel there is sufficient evidence to contra-indicate it absolutely."

On examination she appeared to be a healthy young woman. There were no abnormal cardiac signs. The blood pressure was 150/100, and the optic fundi were normal. No œdema was present. Examination of the abdomen showed no clinical renal enlargement or tenderness, or other abnormality.

She was admitted for observation and investigation. The following results were obtained :

*C.S.U.*: A trace of albumin. *R.B.C.* + +. Culture sterile.

*Blood Urea*: 25 mgm. per cent.

*Urea clearance*: 77 per cent. (standard).

*Urea Concentration Test, and Concentration and Dilution Test*: Normal.

*Chest Radiogram*: Normal.

*I.V.P.*: Straight radiogram—normal. Immediately after injection the patient vomited and collapsed. The radiologist reported: "There was virtually no concentration to 35 minutes, when the patient was returned to the ward. It is difficult to say if this lack of concentration is due to renal or pre-renal causes."

During her stay, the blood pressure remained at about 150/100. She left hospital on 27.7.53.

She was readmitted on 7.12.53, having been under observation by her unit medical officer in the meantime. The following investigations were done:

*C.S.U.*: Albumin +. Culture sterile.

*Blood Urea*: 15 mgm. per cent.

*Urea clearance*: 67 per cent. (standard).

*Concentration and Dilution Test, and Urea Concentration Test*: Normal.

She was discharged on 15.12.53. The blood pressure during this period varied between 145/95 and 150/100.

She was sent in again on 29.12.53 because her blood pressure was reported to have risen to 160/110. On examination of the abdomen, she was 32 weeks pregnant, with a vertex presentation and audible fetal heart. Otherwise, physical examination revealed no change. The optic fundi were normal, no œdema was present, and the urine was albumin-free.

On 4.1.54 the blood urea was still normal, 20 mgm. per cent. and the urea clearance value 61 per cent. (maximum). The blood pressure had been varying between 135/90 and 160/110, on complete bed rest and barbiturates.

On 11.1.54 the blood urea had risen to 45 mgm. per cent., and the urea clearance had fallen to 31 per cent. (standard). The blood pressure was 150/110, and there was no albuminuria or œdema. At this point it was considered that, in view of this evidence of deterioration in renal function, delivery should be effected in the interests of both mother and baby. The fetus felt a good size for the maturity.

Accordingly, on 13.1.54, a lower segment Cæsarian section was performed. The operation was uneventful, and a living male child weighing 5 lb. 15 oz. was delivered, which cried after injection of lobeline.

The post-operative course was uncomplicated. The blood urea was 45 mgm. per cent. on the day after operation, and had fallen to 30 mgm. per cent. by 18.1.54, and to 20 mgm. per cent. by 26.1.54. The urea clearance on 26.1.54 was 77 per cent. (maximum). Lactation was unsatisfactory, and the infant was given artificial feeds, on which it thrived. The patient was discharged on 28.1.54. Her blood pressure was then 150/100.

She was seen post-natally on 1.3.54. She was well. The blood pressure was 170/100. As this patient returned to the U.K. shortly afterwards, a more extensive follow-up was not possible.

## DISCUSSION

The incidence of chronic nephritis occurring in pregnant women is stated as 1 in 1,000 (Browne, 1951).

The differential diagnosis in this case was between essential hypertension and chronic nephritis of Ellis Type 1, although there was no history of acute nephritis. The only other possibility, that of "surgical" renal disease causing hypertension, although it could not be finally disproved owing to the danger associated with an I.V.P. in this particular patient, was made very unlikely by the absence of any history of urinary infections, and the absence of calculi on radiography.

Diagnosis of chronic nephritis from essential hypertension may be impossible when the patient is seen for the first time (Clayton and Oram, 1951), before the additional strain thrown upon the kidneys by pregnancy aggravates slight latent renal impairment and makes it detectable clinically.

Renal damage in essential hypertension occurs only in an advanced stage of the disease, when the blood pressure has risen to a much higher level than was seen in this case, and when other signs of cardiovascular hypertrophy, such as cardiac enlargement and vascular changes in the fundi, have appeared (Clayton and Oram, 1951). These were absent in this case, and renal damage, as shown by the sharply-falling urea clearance and rising blood urea, occurred when the blood pressure was only moderately raised. In the pregnant woman, a blood urea of more than 40 mgm. per cent. is strongly suggestive of renal damage (Clayton and Oram, 1951). The blood urea and urea clearance rapidly became normal after delivery, when the renal function was presumably again sufficient for the needs of the mother alone.

The course of pregnancy is considered to have confirmed the diagnosis of chronic nephritis. The fetal mortality in this condition is estimated at about 40 per cent. (Dodds and Browne, 1939). The risk to the patient is difficult to assess because of the small number of cases met with in pregnant women, but pregnancy apparently worsens the course of the disease to some extent (Browne, 1951; Clayton & Oram, 1951; Eastman, 1950). Delivery before term usually becomes necessary, and, in a primagravida, such a premature delivery is best achieved by Cæsarian section.

## SUMMARY

A case is reported of pregnancy in a patient previously diagnosed as having chronic nephritis. Cæsarian section was done at 35 weeks because of evidence of renal insufficiency.

I wish to thank Dr. J. C. Harland for permission to quote his report on this patient.

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## NON-MANNITOL FERMENTING STRAINS OF SHIGELLA FLEXNERI 4 ISOLATED IN HONG KONG

BY

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It has long been the custom to separate the *Shigellæ* into two main groups according to whether they ferment mannitol or not. *Shigella flexneri* is classically regarded as a mannitol-fermenting organism, but a number of exceptions to this rule have been reported. Perhaps the best known example is the organism originally described by Clayton and Warren (1929*a*, 1929*b*) as the Newcastle dysentery bacillus and subsequently classified as a strain of *Sh. flexneri* 6 (Boyd, 1940).

Since Denier and Huet (1913) isolated a non-mannitol-fermenting dysentery bacillus in Saigon in 1912 a number of reports have been published from different parts of the world describing the isolation of similar organisms. When first described these organisms were often given specific names, *e.g.*, Saigon bacillus, *Shigella saigonensis*, *Bacillus rabaulensis* and *Shigella rio*. Further work has established that these organisms are variants of *Sh. flexneri* 4, and the Enterobacteriaceæ Sub-committee have decided that there is no case at present for placing these organisms in a separate sub-type (Kauffmann, 1954).

MacLennan (1945) mentions the isolation in Middle East of six non-mannitol-fermenting strains of *Sh. flexneri* 103 (*Sh. flexneri* 4), and Nelson (1947) recorded an outbreak of six cases in the Gold Coast caused by this variant.

Recently Ewing (1954) reviewed the published descriptions of non-mannitol-fermenting strains of *Sh. flexneri*. These now include variants of *Sh. flexneri* 1*b*, 2*a*, 3, 4 and 6.

Gardner (1929) pointed out that some Flexner strains fail to ferment mannitol on first isolation but gain the power to do so on sub-culture, and also drew attention to the fact that some freshly isolated organisms produce only transient acidity in 1 per cent. mannitol but permanent acidity if 2 per cent. is used.

This paper is based on a study of thirteen non-mannitol-fermenting strains of *Sh. flexneri* 4 isolated in Hong Kong during 1949-1952. Only ten strains were available when the investigation was completed after an unavoidable interval of over two years.

Recently a further non-mannitol-fermenting strain of *Sh. flexneri* 4 has been identified at the David Bruce Laboratories (Neal, 1955). This organism was isolated elsewhere from a soldier who had returned to the United Kingdom from Hong Kong.

## INVESTIGATIONS

*Source of Organisms*

All organisms were isolated from British troops admitted to hospital suffering from diarrhoea or frank dysentery. One case was moderately severe, the remainder mild, and all responded to sulphaguanidine.

*Stool Exudate*

The stool exudates were classified as bacillary, 7; indefinite, 5; and no record, 1.

*Isolation of Organism*

The stools plated on desoxycholate-citrate agar produced a heavy growth of non-lactose-fermenting colonies similar to those of *Sh. flexneri*. The organism was a non-motile Gram-negative bacillus.

*Biochemical Reactions*

The biochemical reactions are given in Table 1. All sugars were incubated for 28 days.

TABLE 1

Lactose	...	...	...	...	—	Adontol	...	...	...	...	—
Glucose	...	...	...	...	A <sup>1</sup>	Inositol	...	...	...	...	—
Mannitol*	...	...	...	...	—	Maltose	...	...	...	...	A <sup>1</sup>
Dulcitol	...	...	...	...	—	Indole	...	...	...	...	+
Sucrose	...	...	...	...	—	MR	...	...	...	...	+
Salicin	...	...	...	...	—	VP	...	...	...	...	—
Rhamnose	...	...	...	...	A	H <sub>2</sub> S	...	...	...	...	—
Sorbitol	...	...	...	...	A <sup>1</sup> -A	Urea	...	...	...	...	—
Xylose	...	...	...	...	A	Koser	...	...	...	...	—
Arabinose	...	...	...	...	A <sup>1</sup>	Gelatin	...	...	...	...	—

A<sup>1</sup>=Acid, no gas in one day, etc.  
—=No acid or negative.

A = Reaction variable.  
\* = 2 per cent. mannitol.

No strain even after five years has shown any tendency to ferment mannitol, and frequent sub-culturing daily for 28 days on two occasions has not induced the ability to do so. In an attempt to demonstrate mannitol-fermenting variants in these cultures, six strains were plated out on a bile-salt neutral-red mannitol agar, but no mannitol-fermenting colonies were detected.

*Serology*

Preliminary slide agglutination excluded all organisms of Shigella Group A (*Sh. shigæ*, *Sh. schmitzii*, etc.) and Group D (*Sh. sonnei*). Some strains gave weak slide agglutination with polyvalent Shigella Group C sera (*Sh. boydii*) and with several monovalent sera of that group, but tube agglutinations proved that the relationship was insignificant.

All strains gave strong slide agglutination with polyvalent *Sh. flexneri* A 2 (which comprises antibodies to *Sh. flexneri* 4-6) and with monovalent *Sh. flexneri* 4 sera. Suspensions were prepared from ten strains and eight of these were agglutinated to titre by monovalent *Sh. flexneri* 4 serum (titre 1 in 250); two strains were agglutinated to titre of 1 in 125.

A rabbit was immunized with one of the strains (K.1). The serum of this

rabbit agglutinated K1 to a titre of 1 in 2,500 and a stock *Sh. flexneri* 4 to a titre of 1 in 5,000 (a difference of only one tube). Cross-absorption tests with this serum and suspension of K1 and *Sh. flexneri* 4 confirmed the close antigenic relationship of the two organisms.

#### DISCUSSION

Although the fermentation of mannitol has been used to divide the *Shigella* into two main biochemical groups, it is becoming increasingly apparent that this distinction does not provide a sound basis for classification. Nelson (1947) has stressed the unreliability of any classification on biochemical reactions, and Weil (1947) has gone so far as to question whether this division should be maintained. The only satisfactory classification is a serological one.

There appears to be little tendency to overlook non-mannitol-fermenting strains of *Sh. flexneri* 6, perhaps because they have for many years been given independent status as the Newcastle bacillus, but the possibility that a non-mannitol-fermenting dysentery organism may be one of the other types of *Sh. flexneri* should always be borne in mind. If this is done and a systematic serological investigation made by the use of polyvalent antisera it may transpire that these variants are more common than is believed at present.

#### SUMMARY

1. The occurrence of thirteen cases of dysentery caused by a non-mannitol-fermenting dysentery organism is described.
2. The laboratory investigations leading to the identification of these organisms as *Sh. flexneri* 4 are described.
3. The importance of bearing in mind the fact that a non-mannitol-fermenting organism may be *Sh. flexneri* is stressed.

#### ACKNOWLEDGMENTS

I wish to thank the various laboratory technicians who have assisted me during this investigation.

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## AN ATYPICAL RICHTER'S HERNIA

BY

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RICHTER'S hernia commonly presents as partial or complete intestinal obstruction ; Kirkman (1951), in a recent survey of fifteen cases, stressed that there was nothing in the symptomatology to differentiate a Richter's hernia from cases where the complete circumference of the bowel was strangulated. Ninety per cent. are femoral, according to Foltz, (1947), so that this case, presenting as a "cold" right inguinal hernia, is considered worthy of record, especially as the literature on the subject is not very extensive.

*Case History.*—The patient, a gunner aged 18, had noticed a swelling in his right groin on and off for ten years. One day before admission he had some dull, aching pain associated with the swelling. There were no other symptoms. A typical expansile impulse was obtained on coughing, but minimal tenderness to touch was noticed by his unit M.O. On this account he was transferred to hospital for observation.

The aching pain settled within six hours of admission and nothing abnormal was found, apart from a typical reducible right inguinal hernia. In view of the history, it was decided to keep him in hospital. During this time the patient was up and about, symptom-free, with no abnormal physical signs.

On the tenth day after admission the right inguinal hernia was explored under general anaesthesia. At the level of the internal ring, a globular, tense, cystic swelling  $1\frac{1}{2}$  inches by 1 inch was discovered, and found to be a typical Richter's hernia, the sac containing some blood-stained fluid ; the congested oedematous loop involved about four-fifths of the bowel lumen. Thick adhesions to one point on the neck of the sac were divided, and the loop freed in the usual manner, and after a suitable period of observation this was returned to the abdomen. A Tanner Slide modification of Bassini repair was carried out.

The post-operative period was uneventful, and during this time his pre-operative history was again checked and no abnormal symptoms recalled.

Apart from aching pain in the groin ten days prior to operation, there is a striking lack of symptoms in this case. It seems, therefore, that it is desirable not to postpone operation where pain is present or has recently occurred in any hernia.

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## *Editorial*

As we go to press, we deeply regret to announce the death of our Editor, Colonel J. B. Neal, T.D., R.A.M.C. An obituary notice will appear in our next number.

### THE SOLDIER'S CHEST

IN this issue appears the first of a projected series of articles from the Army Chest Centre, a study of upper respiratory tract infections. Whether to bullets or to bacteria, the soldier's chest is a very vulnerable part of him, and it is perhaps surprising that the Army had to wait so long for a special centre for diseases of the chest. That it has may not be unconnected with the fact that over many years the preponderant incidence of tuberculosis in the Army fell upon the Household Cavalry and Foot Guards. They maintained their regimental hospitals, thus keeping their consumptives in a close preserve, long after the general hospital system had been established for the rest of the Army, while, by coincidence, fifty years of well-founded sanitary doctrine led to a decline in tuberculosis in the Service at just about the time when the Guards' hospitals were abolished.

Since 1901 there has been a steady and continued reduction in the military tuberculosis rate, interrupted only by a sharp rise in 1945 due in part to returning prisoners of war and in part to better early recognition of the disease in National Service men. To that rise is due the inception of the Army Chest Centre. During the war of 1939-1945, the period during which a man could be treated at service expense, while he continued to receive service pay, was gradually extended to two and a half years. Tuberculosis patients were, however, treated not in military hospitals but in civilian sanatoria. From 1945 it became increasingly difficult to find civilian beds for Army patients, and the difficulty was overcome by setting aside beds in military hospitals—300 in the Connaught, 100 at Cowglen, and 10 at Waringfield. The Connaught Hospital, in its new location at Hindhead, was situated in ideal countryside for those with chest complaints—the King Edward VII Sanatorium, not far away at Midhurst, bore witness to this. In 1949 the skin and venereal disease departments, which it had retained from its role in Aldershot, were moved elsewhere, and tuberculosis beds were increased from 300 to 450.

At the same time a small department was opened for chest conditions other than tuberculosis, and in 1950 facilities were provided for minor thoracic surgery. Major surgery upon officers was carried out at Midhurst, and upon other ranks at the Royal Naval Hospital, Chatham. From this time the Connaught Hospital became more and more a chest hospital rather than a sanatorium, and the staff

were free to develop their interest in the non-tuberculous infections of the respiratory tract, of which the first fruits are printed in this number. The seal was set upon this change by the specific addition of the parenthetical title "(The Army Chest Centre)" to the name of the Connaught Hospital in October, 1954.

A survey of the military development of both diseases and wounds of the chest reveals two outstanding points—first, that although the drugs and techniques used have changed, principles remain virtually unaltered, and secondly, the growing integration of medical and surgical aspects of the treatment of chest disorders. Surgery is increasingly employed in the therapy of pulmonary tuberculosis, bronchiectasis and other "medical" diseases of the lungs; while Boland, addressing a conference of Army physicians at Rome in 1945, could attribute to the work of the forward surgeons and the forward physicians the improved condition in which men wounded in the chest had been arriving at the special centres during the previous twelve months.

Understandably, military surgery has a longer history than military medicine, and the maintenance of principles in the treatment of war wounds of the chest can be studied in a few easily accessible articles. Gask dealt in his Lettsomian lectures\* for 1921 with the period from the thirteenth century to the end of the First World War. Mercer's study† summarizes the experience of 1914-1918, as modified by events in China and Spain. The opinions of chest surgeons on the position in their speciality while the 1939-1945 war was in progress are briefly given in papers by Tudor Edwards, Welch, and Sellors,‡, and modern army doctrine is explained in *A Field Surgery Pocket Book* (revised, 1950).

Compare Mondeville (quoted by Gask) in the early thirteenth century: "Recent wounds which penetrate the cavity of the chest . . . should be closed more quickly, should be joined more strongly, and should be sutured by stitches closer and tighter, even though they may be smaller than wounds of other parts . . .," with *A Field Surgery Pocket Book*: "The essential is immediate closure of the wound to prevent the sucking noise and to render it air-tight." Or Gale (also quoted by Gask) in 1944 on foreign bodies in chest wounds: "Use a probe and try to get it out, but if you cannot without great pain and searching find the bullet, leave it alone . . .;" with Tudor Edwards in 1945: "The foreign body, unless easily palpated and removed when the empyema is drained, should be left . . ."

On the medical side, substitute isoniazid for copaiba, and the minor surgery of artificial pneumothorax for the minor surgery of bleeding and blistering, and who would quarrel with Monro's régime for the consumptives of the British Army in Germany in 1761-1763, of "as free and pure Air as the Nature of the Hospital would admit of," gentle exercise in the daytime when the weather was good, and billeting-out of patients "when we knew the men to be sober, and not apt to commit irregularities."

\* Reprinted in *Essays in the History of Medicine*, by George Gask. London: Butterworth, 1950.

† Essay on "Surgical Treatment of Chest Injuries" in *War and the Doctor*, edited by J. M. Mackintosh. Edinburgh: Oliver and Boyd, 1940.

‡ In *Inter-Allied Conferences on War Medicine convened by the Royal Society of Medicine, 1942-1945*, edited by Major-General Sir Henry Letheby Tidy and J. M. Browne Kutschbach. London: Staples, 1947.

The Army's attitude to tuberculosis has, certainly for two hundred years, been based upon three principles : keep it out, pick it out, board it out : all easier said than done. Keeping tuberculosis out of the Service depends upon close examination of recruits, more practicable by mass miniature radiography than by the opinion of even two surgeons on the significance of "scars of scrofulous ulceration" or "want of capacity of the chest." Detection, too, has been facilitated by the same means, and the discharge of patients from the Service has been shown to be differently conducted since the days of Henry Marshall\* : "When the external and functional symptoms of disease, together with the stethoscope, indicate a material disorganization of the substance of the lungs of a soldier, it is in general deemed expedient to recommend him to be discharged. The stethoscope in the hands of an adept is highly useful in detecting the simulator of consumption—a class of imposter who are found in all general hospitals, and sometimes also in regimental hospitals."

This circumstance, of requiring evidence of extensive lung destruction before invaliding was even considered, persisted for the next half-century, for Surgeon F. H. Welch†, in his essay on Pulmonary Consumption which won him the Alexander Prize for 1872, says : "No small amount of early and unpronounced disease finds a refuge under the heading of Bronchitis . . . There is the necessity of getting rid of all phthisical cases by invaliding, but for this purpose the disease must be advanced ; an antipathy against a man who has once figured under phthisis being returned to the ranks ; there is the doubt cast by the Medical Officer himself upon his own previous diagnosis when the case does well, the idea of phthisis being necessarily progressive and irremediable being all but a dogma of medical science, and widespread in influence." As assistant professor of pathology at Netley, then the general invaliding depot for the whole army, Welch had excellent factual grounds on which to base his opinion.

Throughout the nineteenth century, when tuberculosis was the principal cause of admission to hospital and of mortality in the Army, the rate of rejection of would-be recruits was high : from 1842-1851, 335 per thousand, including 27.8 per thousand for "tendency to consumption" and "want of due capacity or malformation of the chest" ; from 1860 to 1869, the figures are 405 and 113.26 per thousand. But in the overcrowded barrack rooms of the day—"a soldier never knows a healthy home as regards air and space until he commits some crime which brings him into the thoroughly ventilated cell of a military prison"—to which the early and unpronounced "bronchitics," were constantly returning, what hope could there be of any but an excessive tuberculosis rate?

It is customary to reckon the modern history of tuberculosis from Koch's isolation of the tubercle bacillus in 1882. But it might well have started fifteen years earlier, for in 1865 Jean-Antoine Villemin, *professeur agrege* at the French Army Medical School of Val-de-Grace, began the studies on transmissibility of tuberculosis of which the definitive results were published in 1868. His experiments conclusively showed that tuberculosis was due to a specific agent—"un

\* *On the Enlisting, Discharging and Pensioning of Soldiers*. Edinburgh: 2nd Edition, 1829, p. 108.

† A M.D. Report for 1872, Vol. 14. London : 1874, p. 294.

*agent plus subtil qui s'y trouve contenu et qui echappe à nos sens*"—and that it was inoculable from man or cow to rabbit or guinea-pig, and in unending series from one infected animal to another.

It was farther to Paris from London then than now, but astute minds in England saw the significance of this work. John Simon went to Paris with Burdon-Sanderson and wrote in his Tenth Report to the Privy Council (1867): "Various observers (among whom I was one) were soon able to satisfy ourselves that M. Villemin's descriptions were entirely true within the field within which he experimented." He recommended that further research be undertaken. Villemin's findings might have been expected at least to have come to Welch's notice, and to have merited some assessment, but there is no mention of them in the essay of 123 printed pages which gained him the Corps' principal prize.

Welch had been brought up under Sir William Aitken, an excellent teacher, a shrewd observer and adept at correlating morbid findings with clinical processes, but not, however, an experimental pathologist. Neither Welch's essay on pulmonary consumption nor his second Alexander Prize thesis on enteric fever shows any sign of an experimental approach. When Aitken died, Welch's claims to the chair of pathology at Netley were strongly pressed within the Army Medical Department and outside it, but Almroth Wright was appointed. Wright's selection was not universally popular, nor were his relations with the Army always harmonious, but we may rejoice that he introduced to the Army Medical School, as Welch would almost certainly not have done, the experimental method which has long been the pride and is still the strength of the Army Medical Services.

From Wright's time onward, it was almost traditional that the professor of pathology at the Army Medical School (Royal Army Medical College) should maintain an interest in tuberculosis, though that interest appeared to wane after the retirement from the service of Lyle Cummins, the most distinguished of them all in that field. Happily, there has been a revival under the present professor in connection with the Army's B.C.G. Scheme, which he played a great part in launching in November, 1950, and which was extended last year. The Army Chest Centre is, of course, intimately concerned in this work, and recent papers in this Journal have shown that there is interest in diseases of the chest at the periphery as well as at the Centre. This augurs well for still further depression of the incidence of tuberculosis in the British Army.

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#### ERRATUM

In the article "Medical Avernus" in the July, 1955, number, page 221 :

*Lines 27 and 28 : for "one hour in a space one square mile"*

*read "three hours upon a space of one mile square"*



## *Matters of Interest*

### PRIZE ESSAYS

1. GEORGE KNIGHT CLOWES memorial prize essay, 1956.

Prizes : First prize, £35 ; second prize, £15.

Closing date : 8th January, 1956.

Subject : "What are your views on the form of the land campaign of the future, and how should the British Army be organized to meet the conditions of future war—bearing in mind its possible varying commitments".

General conditions will be the same as for the 1955 competition and are contained in A.C.I. 479/54.

2. GOLD MEDAL AND TRENCH GASCOIGNE prize essay competition, 1955.

Prize : Thirty guineas and Gold Medal.

Closing date : 15th November, 1955.

Subject : (i) Air Power is indivisible (Field-Marshal Montgomery, October, 1954). Discuss this statement.

- (ii) The use of atomic and thermo-nuclear weapons in war suggests that a future war will be one of survival. Bearing in mind the vulnerability of the British Isles to air attack, what practical measures do you consider should and could be taken now to bring about the greatest possible chance of national survival?

General conditions for the essays are contained in A.C.I. No. 142/1955.

### TOBRUK 41

The ninth Tobruk 41 Officers' Dinner will be held at the Connaught Rooms, London, on Friday, 18th November. Detailed particulars from : Major-General C. E. N. Lomax, C.B., C.B.E., D.S.O., M.C., c/o The Barracks, Cardiff, S. Wales.

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### *Book Reviews*

FRACTURES AND JOINT INJURIES. Watson-Jones, Vol. II. Livingstone. Pp. 1073 and vii. Illustrated. £6 (per set).

This volume gives the present views on this work. It contains new material and is excellently produced. It must be read and should be possessed by surgeons of the Corps. But six pounds is a lot of money even though it is quite the most outstanding book on its subject.

**SPOT DIAGNOSIS, Vol. II.** Compiled by the Editors of *Medicine Illustrated*. London : Harvey & Blythe Ltd., 1955. Pp. 127. 8s. 6d. Illustrated.

An excellent book for "parlour games for clinicians" in isolated hospitals. Worth while at 8s. 6d.

C.M.M.

**DOCTOR AT WAR.** Ion Ferguson. Christopher Johnson Ltd. (Illustrated 15s.).

An Irish M.Os. experiences in Greece before he was captured with No. 26 General Hospital, and then his experiences as a P.O.W. Very readable.

C.M.M.

**PERIPHERAL NERVE INJURIES.** M.R.C. Special Report Series No. 282. H.M.S.O. Pp. 451. £2 15s. Illustrated.

This book is a collection of monographs written by those who gained vast experience in these injuries during the last war. It is excellent and will be the standard reference book for many years. A book for the library.

C.M.M.

**POLIOMYELITIS.** Debre *et al.* W.H.O. Monograph Series No. 26. Pp. 408. £2.

This is an authoritative survey of the subject by experts from many nations. It is divided into sections on epidemiology, clinical aspects, virology, immunology and control, and will form a valuable work of reference for workers engaged in all aspects of the disease. Whilst being topical (sixty pages are given to papers discussing vaccination) there is much in the book which is not likely to date rapidly. Ventilation is discussed in detail, with particular reference to bulbar poliomyelitis. The laboratory aspect of the subject is dealt with thoroughly, and there are good descriptions of techniques. The bibliographies are full, and the illustrations are clear. The book is well printed on good quality paper and maintains the high standard in subject matter and production which distinguishes the series of W.H.O. Monographs.

R.J.C.H.

**HISTORY OF THE SECOND WORLD WAR.** The Royal Air Force Medical Services.

Vol. I. Administration. H.M.S.O. Price £3 10s. Pp. 611. Plates 68.

In his preface Air Marshal Kilpatrick puts the provision of points of reference for planning in the future last among the aims of this history. Yet it is felt that this will prove to be its main use.

The abundance of material to be included inevitably detracts from the readability of the narrative and few will read it from cover to cover. Nor will the planner and historian seeking facts and figures find their task easy. They would have been helped by a fuller index and better cross-references.

There are 68 plates but many fail to amplify the text and are unlikely to be of much historical interest to generations to come. Those illustrating the chapter on Air Evacuation, for example, do not show us how stretchers were

disposed or secured in the aircraft. Plates 51 and 56 are essentially similar and the subject-matter hardly merits one insertion, let alone two.

A little more selectivity might, too, have been applied to the tables of statistics, some of which have little significance.

Throughout the book one is struck by the high standards of accommodation, equipment and manpower demanded by the R.A.F. In the best traditions of their service they sought the stars. Yet one has the uncomfortable feeling that in pursuing their own requirements they did not take sufficient account of the legitimate claims of other Services and of the civilian population on resources which were very limited. Disparity between the standards provided by the three Medical Services of the Armed Forces might well lead ultimately to a unified Service, and the R.A.F. would be amongst the first to deplore such an event.

In the short histories of the individual hospitals in the U.K. (Chapter 5) there is much repetition and a general survey would have sufficed.

Nevertheless the Editor is to be congratulated on producing a book of great value to historians. He himself qualified about half-way through the war and consequently must have surveyed the scene from a plane nearer to the worm's-eye view than that of the soaring eagles. Yet he has successfully brought into perspective the most eventful years in the history of the Royal Air Force Medical Services.

H.R.M.

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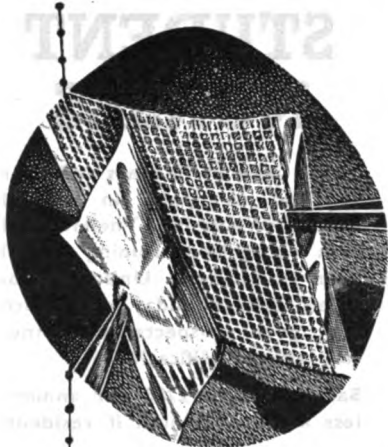
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